随机矩阵计算与智能深度学习
学术研讨会

会

议

手

册

河北师范大学 数学科学学院

2025 年 10 月 30 日-11 月 3 日

中国 石家庄

会议须知

一、会议时间

2025 年 10 月 30 日-11 月 3 日。

10 月 30 日（周四）报到，11 月 3 日（周一）离会。

二、报到和住宿安排

入住观和国际酒店（石家庄市裕华区裕翔街 18 号，河北师范大学东门）。

酒店服务电话：0311-80981166

三、就餐安排

用餐时间：早餐 7:00—9:00；午餐 12:00—13:30；晚餐 18:00—19:30。

用餐地点：观和国际酒店一楼自助餐厅，有特殊就餐要求请提前联系会务组。

四、会场安排

会议地点：数学科学学院（田家炳教育书院）二楼，理科群 D203 会议室。

五、会务联系

王璐　13315957011　wanglu@hebtu.edu.cn

李秀丽　15081197030

会议日程

10 月 30 日（周四）	
15:00--18:00	报到
18:00--19:30	晚餐

10 月 31 日（周五）		
7:00--9:00	早餐	
9:10--9:35	开幕式、合影	主持人：王璐
9:35--10:25	邀请报告	主持人：杨爱利
	On Kaczmarz-like Block Iterative Methods for Solving Large-Scale Systems of Linear Equations	报告人：黄正达
10:40--10:55	茶歇	
10:55--11:45	邀请报告	主持人：曾闵丽
	Some Kaczmarz-Type Methods for Solving Linear and Nonlinear Systems of Equations	报告人：李维国
12:00--13:30	午餐	
15:00--15:50	邀请报告	主持人：王丽
	On Convergence Analysis and Efficiency Comparison for Kaczmarz-Type Iteration Methods and Coordinate-Descent-Type Iteration Methods	报告人：王璐
16:05--16:15	茶歇	
16:15--17:40	主题研讨：随机矩阵计算	主持人：白中治
18:00--19:30	晚餐	

11 月 1 日（周六）		
7:00--9:00	早餐	
9:10--10:05	邀请报告	主持人：黄玉梅
9:10--9:35 9:40--10:05	The Wasserstein Metric Matrix and Its Computational Property	报告人：白中治
10:10--10:35	邀请报告	主持人：王俊刚
	A Novel Regularization Paradigm for the Extreme Learning Machine	报告人：吴庆标
10:40--10:55	茶歇	
10:55-11:50	邀请报告	主持人：张建军
10:55--11:20	Randomized CUR Matrix Decomposition	报告人：刘皞
11:25--11:50	Fake News Classification Using CP Decomposition and Graph Convolutional Network	报告人：周丙寅
12:00--13:30	午餐	
15:00--16:10	邀请报告	主持人：王学忠
15:00--15:20	An Improved SSOR-Like Preconditioner for the Non-Hermitian-Positive Definite Linear System with a Dominant Skew-Hermitian Part	报告人：宋胜重
15:25--15:45	Minimizing Synchronizations in IDRstab Algorithm for Distributed Parallel Computing	报告人：孟静
15:50--16:10	Improved Modulus-Based Matrix Splitting Iteration Methods for a Class of Horizontal Implicit Complementarity Problems	报告人：王鲁欣
16:15--16:30	茶歇	
16:30--17:40	邀请报告	主持人：路康亚
16:30--16:50	Two Variants of Cosine Distance-Driven Accelerated Block Kaczmarz Algorithms	报告人：邵新慧
16:55--17:15	A New Greedy Two-Dimensional Extended Gauss-Seidel Method for Least Squares Problems	报告人：张建华
17:20--17:40	A Multi-Parameter Preconditioner for Double Saddle Point Problem Arising from Liquid Crystal Directors Modeling	报告人：吴波
18:00--19:30	晚餐	

11 月 2 日（周日）		
7:00--9:00	早餐	
9:10--10:35	邀请报告	主持人：郭晓霞
9:10--9:35	A Modulus-Based Multigrid Method for Nonlinear Complementarity Problems with Application to Free Boundary Problems with Nonlinear Source Terms	报告人：张丽丽
9:40--10:05	A Sparse Power Method with Extrapolation for the Higher-Order PageRank Problem	报告人：吴钢
10:10--10:35	Eigenvalues Estimation of Saddle Point Matrix from the Legalization Problem of Integrated Circuit Layout Design	报告人：曹阳
10:40--10:55	茶歇	
10:55--11:50	邀请报告	主持人：苗存强
10:55--11:20	On the Adaptive Deterministic Block Kaczmarz Method with Momentum for Solving Large-Scale Consistent Linear Systems	报告人：郭学萍
11:25--11:50	Irregular Tensor Singular Value Decomposition for Single-Cell Multi-Omics Data Clustering	报告人：崔鲁宾
12:00--13:30	午餐	
15:00--16:10	主题研讨：矩阵计算与深度学习	主持人：王璐
16:10--16:30	茶歇	
16:30--17:40	主题研讨：矩阵计算教学与学生培养	主持人：王延萌
18:00--19:30	晚餐	

11 月 3 日（周一）
离会

Abstracts

The Wasserstein Metric Matrix and Its Computational Property

Zhong-Zhi Bai

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Abstract

By further exploring and deeply analyzing the concrete algebraic structures and essential computational properties about the Wasserstein-1 metric matrices of one- and two-dimensions, we show that they can be essentially expressed by the Neumann series of nilpotent matrices and, therefore, the products of these matrices with a prescribed vector can be accomplished accurately and stably in the optimal computational complexities through solving unit bidiagonal triangular systems of linear equations. We also give appropriate generalizations of these one- and two-dimensional Wasserstein-1 metric matrices, as well as their corresponding extensions to higher dimensions, and demonstrate the algebraic structures and computational properties of these generalized and extended Wasserstein-1 metric matrices.

Eigenvalues Estimation of Saddle Point Matrix from the Legalization Problem of Integrated Circuit Layout Design

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Abstract

Converting the legalization problem of integrated circuit layout design into a linear complementary problem with the system matrix being of saddle point matrix structure has many advantages, and the efficient numerical solution algorithm of the latter is closely related to the eigenvalues distribution of the saddle point matrix. In the case where the standard cell has a single row height, we analyze in detail the eigenvalues estimation of the saddle point matrix. Theoretical analysis indicates that some eigenvalues of this kind of saddle point matrices are 1, and the remaining eigenvalues are distributed on two mutually perpendicular line segments centered on $(\frac{1}{2}, 0)$ in the complex plane. Moreover, we provide the exact upper and lower bounds of both the real eigenvalues and the imaginary parts of complex eigenvalues. In the case where the standard cell has a mixed row height, we present the conditions that the eigenvalues are real. For real eigenvalues, we provide their upper and lower bounds. For complex eigenvalues, we provide the upper and lower bounds of the real part, as well as the upper bound of the imaginary part. Finally, these theoretical results are verified through several numerical examples.

MPST: Transformer-Based Multimodal Sleep Staging with Prompt Learning

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Abstract

Sleep disorders have emerged as a critical public health issue due to their significant impact on daily functioning and their well-established associations with both physical and mental health conditions. Automatic sleep stage classification systems have thus become essential tools for enabling scalable and objective sleep analysis. While deep learning models based on single modalities – such as EEG signals or time-frequency representations—have shown encouraging results, they often suffer from limited generalization ability and a lack of multimodal signal diversity. To address these challenges, we propose MPST (Multimodal Sleep Prompting Transformer), a novel architecture that effectively integrates EEG and EOG signals for sleep stage classification. MPST is designed to overcome two primary limitations of current multimodal approaches: (1) inadequate modeling of both global and local temporal dependencies across modalities, and (2) loss of complementary and modality-specific information during signal fusion. To this end, MPST introduces a dual-branch stacked framework that preserves modality-specific features and employs prompt-based interaction modules to enable progressive and interpretable cross-modal alignment. We evaluate MPST on the Sleep-EDF Expanded dataset, where it consistently outperforms state-of-the-art baselines across multiple metrics, including accuracy, sensitivity, and specificity. These results highlight the effectiveness of our fusion strategy and the robustness of prompt-driven cross-modal representation learning in enhancing sleep staging performance.

Irregular Tensor Singular Value Decomposition for Single-Cell Multi-Omics Data Clustering

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Abstract

Single-cell multi-omics refers to the various types of biological data at the single-cell level. These data have enabled insight and resolution to cellular phenotypes, biological processes, and developmental stages. Current advances hold high potential for breakthroughs by integrating multiple different omics layers. However, single-cell multi-omics data usually have different feature dimensions and direct or indirect relationships. How to keep the data structure of these different data and extract hidden relationships is a major challenge for omics data integration, and effective integration models are urgently needed. In this paper, we propose an irregular tensor decomposition model (GSTRPCA) based on tensor robust principal component analysis (TRPCA). We developed a weighted threshold model for the decomposition of irregular tensor data by combining low-rank and sparsity constraints, which requires that the low-dimensional embeddings of the data remain low rank and sparse. The major advantage of the GSTRPCA algorithm is its ability to keep the original data structure and explore hidden related features among omics data. For GSTRPCA, we also designed an effective algorithm that theoretically guarantees global convergence for the tensor decomposition. The computational experiments on irregular tensor datasets demonstrate that GSTRPCA significantly outperformed the state-of-the-art methods and hence confirm the superiority of GSTRPCA in clustering single-cell multiomics data. To our knowledge, this is the first tensor decomposition method for irregular tensor data to keep the data structure and hence improve the clustering performance for single-cell multi-omics data.

The Numerical Methods for Solving the Absolute Value Equation

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Abstract

In the paper, a New Gauss-Seidel Iteration method(NGS) is presented to solve nonlinear absolute value equations based on the Gauss-Seidel splitting. Furthermore, a relaxation acceleration method based on residuals is obtained. Under appropriate conditions, the convergence theories of the two methods are proposed. Finally, several numerical examples are given to demonstrate the effectiveness of the NGS method and the relaxation acceleration method.

On the Adaptive Deterministic Block Kaczmarz Method with Momentum for Solving Large-Scale Consistent Linear Systems

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Abstract

The Kaczmarz method is a traditional and widely used iterative algorithm for solving large-scale consistent linear systems, while its improved block Kaczmarz-type methods have received much attention and research in recent years due to their excellent numerical performance. Hence, in this paper, we present a deterministic block Kaczmarz method with momentum, which is based on Polyak's heavy ball method and a row selection criterion for a set of block-controlled indices defined by the Euclidean norm of the residual vector. The proposed method does not need to compute the pseudo-inverses of a row submatrix at each iteration and it adaptively selects and updates the set of block control indices, thus this is different from the block Kaczmarz-type methods that are based on projection and pre-partitioning of row indices. The theoretical analysis of the proposed method shows that it converges linearly to the unique least-norm solutions of the consistent linear systems. Numerical experiments demonstrate that the deterministic block Kaczmarz method with momentum method is more efficient than the existing block Kaczmarz-type methods.

(Joint work with Long-Ze Tan, Ming-Yu Deng and Jing-Run Chen.)

Weighted Nuclear Norm Minimization-Based Regularization Method for Image Restoration

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Abstract

Regularization methods have been substantially applied in image restoration due to the ill-posedness of the image restoration problem. Different assumptions or priors on images are applied in the construction of image regularization methods. In recent years, matrix low-rank approximation has been successfully introduced in the image denoising problem and significant denoising effects have been achieved. Low-rank matrix minimization is an NP-hard problem and it is often replaced with the matrix's weighted nuclear norm minimization. The assumption that an image contains an extensive amount of self-similarity is the basis for the construction of the matrix low-rank approximation-based image denoising method. In this talk, we develop a model for image restoration using the sum of block matching matrices' weighted nuclear norm to be the regularization term in the cost function. An alternating iterative algorithm is designed to solve the proposed model and the convergence analyses of the algorithm are also presented. Numerical experiments show that the proposed method can recover the images much better than the existing regularization methods in terms of both recovered quantities and visual qualities.

On Kaczmarz-Like Block Iterative Methods for Solving Large-Scale Systems of Linear Equations

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Abstract

This report primarily reviews Kaczmarz-type block iterative methods for solving large-scale systems of linear equations, covering both consistent and inconsistent cases, as well as probabilistic and deterministic approaches. We also present our research on the fast deterministic block method based on a greedy strategy [Bai & Wu, SISC, 2018, 40(1), A592-A606] and its subsequent developments. Convergence theorems are provided for the discussed methods, along with corresponding numerical experiments.

Some Kaczmarz-Type Methods for Solving Linear and Nonlinear Systems of Equations

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Abstract

In this talk, we present our main work on Kaczmarz-type methods for solving linear and nonlinear equations.

Firstly, we proposed several new methods with new selection probability strategies or special projection ways for solving a consistent (inconsistent) linear system of equations $Ax = b$. In this part, we focus on two new methods: one is an alternative version of the randomized Kaczmarz method, which selects each row of the coefficient matrix A with a probability proportional to the square of the Euclidean norm of the residual of the corresponding equation; the other is a class of Kaczmarz methods based on oblique projections onto the hyperplane, which is particularly superior to existing methods for systems where the rows of the coefficient matrix A are nearly linearly correlated.

Secondly, a series of Kaczmarz-type numerical methods are proposed for solving the matrix equation $AXB = C$, where the coefficient matrix A may be full rank or rank deficient. These methods are iterative methods without matrix multiplication. Theoretically, the convergences of these methods are proved. The numerical results show that these methods are more efficient than iterative methods involving matrix multiplication for high-dimensional matrices. Meanwhile, these methods can also be used to finding the right inverse, left inverse, inner inverse and Moore-Penrose generalized inverse of a matrix. These methods avoid calculating the product of matrix and matrix and are suitable for large-scale problems.

Thirdly, a class of randomized Kaczmarz-type algorithms is derived for obtaining isolated solutions of large scale well-posed or overdetermined nonlinear systems of equations. This type of algorithm improves upon the classic Newton method: each iteration only requires calculating one row (or multi-rows/multi-columns) of the Jacobian matrix instead of the entire matrix, which significantly reduces the amount of computation and storage. Therefore, these algorithms are referred to as matrix-free algorithms. Based on the different probability selection patterns and greedy strategies for choosing rows (or columns) of the Jacobian matrix, a series of new algorithms for nonlinear systems are proposed: the nonlinear Kaczmarz (NK) algorithm, the nonlinear randomized Kaczmarz (NRK) algorithm, the nonlinear uniformly randomized Kaczmarz (NURK) algorithm, the pseudoinverse-free greedy block nonlinear Kaczmarz method, the greedy Kaczmarz method, and the double stochastic block method.

(Joint work with Wen-Di Bao and Li-Li Xing.)

Keywords: Kaczmarz-type method, oblique projection, residual, generalized inverse, pseudoinverse-free, nonlinear equations, greedy strategy, block method

Randomized Quaternion Generalized Singular Value Decomposition Algorithms with Error Analysis

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Abstract

In high-dimensional data processing, quaternion generalized singular value decomposition (QGSVD) has become one of the most important solvers for advanced mathematical models. However, there are currently less of efficient algorithms for calculating partial quaternion generalized singular values and vectors. When dealing with a quaternion matrix pair of substantial size, we present a stable QGSVD and two randomized algorithms cooperating with structure-preserving and quaternion sampling strategies, and g enerate good low-rank approximations to the original quaternion matrix pair. Explicitly, by leveraging random sampling based on the quaternion normal distribution for the original quaternion matrix pair, we propose both fixed-rank and adaptive randomized algorithms for QGSVD. We also establish different kinds of error bounds for the randomized QGSVD approximation in the theoretical analysis, and illustrate the effectiveness of the randomized QGSVD algorithms by numerical experiments on simulation data and practical color face recognition.

Randomized CUR Matrix Decomposition

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Abstract

In this talk, we address dimensionality reduction in high-dimensional data via the CUR matrix decomposition. We propose a randomized matrix sampling method based on a greedy criterion. Building upon this sampling approach, we develop an iterative scheme to enhance the approximation accuracy of the CUR decomposition, and propose a novel iterative randomized CUR method. Theoretical analysis establishes an upper bound on the expected approximation error and demonstrates exponential decay of the additive error term with increasing iteration count. Numerical examples demonstrate the effectiveness of the proposed method.

Multigrid Method with Greedy Partial Block Jacobi Smoother for Solving Two-Dimensional Space-Fractional Diffusion Equations

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Abstract

Based on the block Jacobi splitting, a kind of *greedy partial block Jacobi* (**GPBJ**) iteration method is constructed by greedily selecting the blocks with relatively large residuals and performing the block Jacobi iteration on the selected blocks. Theoretical analysis demonstrates that the GPBJ iteration is unconditionally convergent if the coefficient matrix of the linear system is H-matrix. Then combining with the alternating direction strategy, the GPBJ smoothed multigird method is designed to solve the discrete linear system of two-dimensional anomalous diffusion equations, where the coefficient matrix is strictly diagonally dominant. Numerical experiments indicate that the multigrid method smoothed by the GPBJ iteration can significantly reduce the computation time for solving the considered discrete linear system.

Keywords: block Jacobi splitting, greedy partial block Jacobi iteration, multigrid method

Theoretical and Computational Properties of Semi-Infinite Quasi-Toeplitz M-Matrices

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Abstract

A quasi-Toeplitz matrix is a semi-infinite matrix of the form $A = T(a) + E$, where $T(a)$ is a Toeplitz matrix with entries $(T(a))_{i,j} = a_{j-i}$, for $a_{j-i} \in \mathbb{C}$, $i, j \geq 1$ and E is a compact correction. Quasi-Toeplitz M-matrices are encountered in the study of quadratic matrix equations arising in the analysis of a 2-dimensional Quasi-Birth-Death (QBD) stochastic process. We investigate properties of such matrices and provide conditions under which a quasi-Toeplitz matrix is an M-matrix. We show that under a mild and easy-to-check condition, an invertible quasi-Toeplitz M-matrix has a unique square root that is an M-matrix possessing quasi-Toeplitz structure. The quasi-Toeplitz structure of the square root of M-matrices provides inspirations for proving spectral properties of the quadratic matrix polynomial $L(\lambda) = \lambda^2 A_1 + \lambda A_0 + A_{-1}$ having quasi-Toeplitz coefficients where $A_1, A_{-1} \geq 0$ and $-A_0$ in addition is an M-matrix. Some issues concerning the computation of square root of quasi-Toeplitz M-matrices are discussed and numerical experiments are performed.

Minimizing Synchronizations in IDRstab Algorithm for Distributed Parallel Computing

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Abstract

Scalability of the IDRstab method suffers from costly global synchronizations that arise in inner products and normalization on massively parallel machines. In this work, an improved parallel IDRstab method is proposed that reduces most global synchronization steps by using the Tall-Skinny QR factorization operations and then schedules more inner products to be calculated at one synchronization point. Some additional floating-point calculations have to be performed, but the time consumed is insignificant compared to the one saved by the communication. Moreover, a preconditioning parallel version of the resulting algorithm is also proposed. Through analyzing the isoefficiency of the Par-IDRstab algorithm, it is proved that the algorithm is superior to the IDRstab algorithm in terms of parallelism and scalability. Simulation results show that the scalability and concurrent communication efficiency of the algorithm are increased by 2.5 times and about 60%, respectively.

Greedy and Clustering-Enhanced Average Block Randomized Kaczmarz Methods for Solving Tensor Linear Systems

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Abstract

For solving the consistent tensor linear system based on t-product, this paper presents two greedy randomized Kaczmarz methods and their frequency-domain versions. We first propose a tensor greedy randomized Kaczmarz (TGRK) method. This method updates the horizontal slice with the largest Frobenius norm in the residual tensor at each iteration, enabling greedy selection of the slice with the maximum information. On this basis, a tensor greedy randomized average block Kaczmarz method based on k-means clustering (TGRABK-kmeans) is further proposed, by performing clustering division on the tensor along the first dimension and combining the average block strategy, in order to fully utilize structural information and accelerate convergence speed. Furthermore, this paper constructs TGRK and TGRABK-kmeans algorithms based on Fourier transform to achieve more efficient calculations, and theoretically proves the convergence of all methods for consistent tensor linear systems. Finally, the experimental results show that the proposed method has good convergence performance and image reconstruction effect on multiple datasets, which verifies its effectiveness.

(Joint work with Yu-Shan Ma and Jun-Gang Wang.)

Two Variants of Cosine Distance-Driven Accelerated Block Kaczmarz Algorithms

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Abstract

For the efficient solution of large-scale sparse linear systems, we first characterize the geometric relationship between the current solution and candidate hyperplanes using cosine distance. Based on this, we develop a cosine distance-driven greedy block Gaussian-Kaczmarz (CD-GBGK) algorithm, and further extend it by introducing a relaxation factor. On this basis, we further propose two variants of cosine distance–driven accelerated block Kaczmarz algorithms. We incorporate a recently proposed quantile-based block selection strategy, where the update set is dynamically determined by the quantiles of cosine distances. This adaptive mechanism selects constraint rows with larger cosine distances, and combined with block updates, it significantly accelerates convergence. Inspired by the idea of average-thresholding, we also design another adaptive deterministic algorithm. In this method, rows with cosine distances exceeding the average threshold are selected when constructing the update set, enabling adaptive adjustment of the update size. This approach avoids the limitations of pre-partitioned blocks and further improves the algorithm's stability and computational efficiency.

(Joint work with Tong-Xi Zhou.)

An Improved SSOR-Like Preconditioner for the Non-Hermitian-Positive Definite Linear System with a Dominant Skew-Hermitian Part

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Abstract

An improved SSOR-like (ISSOR-like) preconditioner is proposed for the non-Hermitian positive definite linear system with a dominant skew-Hermitian part. The upper and lower bounds on the real and imaginary parts of the eigenvalues of the ISSOR-like preconditioned matrix and the convergence property of the corresponding ISSOR-like iteration method are discussed in depth. Numerical experiments show that the ISSOR-like preconditioner c an effectively accelerate preconditioned GMRES.

An Efficient Preconditioned Iterative Method for Solving Discretized Fourth-Order Riesz Spatial Fractional Reaction-Dispersion Equations with Variable Coefficients

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Abstract

In this talk, we present efficient fourth-order numerical methods for solving RSFRDEs with variable coefficients on bounded domains. We discretize the temporal derivative using the Crank-Nicolson scheme and approximate the spatial fractional derivatives with a fourth-order fractional centered difference operator. We analyze the stability and convergence of the proposed schemes in the discrete L2-norm. The coefficient matrix of the discretized linear system is a sum of a diagonal matrix and a diagonally scaled Toeplitz matrix. We develop a scaled Toeplitz splitting (STS) iteration method, construct an STS-based polynomial preconditioner, and use Krylov subspace iteration methods to solve the linear system. We analyze the spectral distribution of the preconditioned matrix and present theoretical convergence results. Numerical experiments demonstrate the efficiency and accuracy of the proposed methods.

Two Kinds of Algorithms for Solving a Class of Nonlinear Complementary Problems

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Abstract

We focus on the nonlinear complementarity problem (NCP). On the one hand, we propose a new class of NCP-functions based on a p-norm with p being any real number in the interval $(1, +\infty)$, and show several related properties of the proposed functions. By utilizing new NCP-functions, we transform NCP into an unconstrained optimization problem and propose the descent algorithm and the hybrid descent algorithm. On the other hand, we transform NCP into a system of nonlinear equations based on the smoothing function, and show several favorable properties of the equations. We develop the inexact regularization Newton algorithm by solving the equations inexactly. The convergence analysis and the numerical experiments of the proposed algorithms are given under some conditions. Numerical experiments show that our algorithms are more efficient than the original algorithms.

The main work of this paper is as follows:

(1) We develop a new class of NCP-functions to propose the descent algorithm and the hybrid descent algorithm. The convergence analysis and the numerical experiments of the two algorithms are given. Numerical experiments show that the proposed algorithms are more efficient.

(2) We propose the inexact regularization Newton algorithm by solving the equation inexactly. The convergence analysis and the numerical experiments are given, and the numerical experiments show that the algorithm has better numerical performance.

(Joint work with Ming-Ling Kang.)

Keywords: NCP, NCP-functions, descent method, inexact regularization Newton method

On Convergence Analysis and Efficiency Comparison for Kaczmarz-Type Iteration Methods and Coordinate-Descent-Type Iteration Methods

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Abstract

The Kaczmarz method is a classical while effective iteration method for solving large-scale consistent systems of linear equations. In this talk, we firstly study the convergence properties and numerical behaviors of some typical randomized and non-randomized Kaczmarz methods with different probability criteria adopted for selecting the working row. We derive sharper upper bounds for the convergence rates of some of the Kaczmarz-type iteration methods. As for the whole suite of the Kaczmarz-type iteration methods, we reveal the comparable relationships in terms of both mean-squared distance and mean-squared error, and show that the experimental results nicely coincide with the theoretical results base on implementing a large number of test examples.

Secondly, for solving the problem that the randomized Kaczmarz (RK) method can not converge when the linear system is inconsistent, the randomized extended Kaczmarz (REK) method are proposed. By introducing two groups of multiple iteration parameters and repeatedly updating the iterate by several times in one iteration step of the randomized extended Kaczmarz method, we propose the multi-step randomized extended Kaczmarz (MREK) method. The upper bound for its convergence rate can be improved and be smaller than the upper bound for the convergence rate of the REK method in some special cases. Moreover, with numerical experiments we demonstrate that the MREK method with a proper choice of the multiple iteration parameter can show advantages than the REK method in terms of both iteration steps and computing times.

Thirdly, the randomized coordinate descent (RCD) method is another effective and widely-used randomized iteration method for solving inconsistent linear systems, which together with the RK method can be regarded as two special cases of the randomized multiplicative Schwarz method. We show the close relations between the RK method and RCD method with respect to convergence conclusions and algorithmic improvement, finding that the coordinate-descent-type methods can be obtained from the corresponding Kaczmarz-type methods, including their convergence theorems, and vice versa.

Improved Modulus-Based Matrix Splitting Iteration Methods for a Class of Horizontal Implicit Complementarity Problems

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Abstract

Recently, the modulus-based matrix splitting (MMS) iteration method has been successfully extended to solve the horizontal implicit complementarity problem (HICP). However, due to the existence of two system matrices and one nonlinear term, in addition to an equivalent fixed-point equation of the HICP, a system of linear equations has to be solved at each iteration to satisfy both the nonnegative constraint and the orthogonal constraint. This costs very expensive. In this paper, by introducing an additional judgement criterion after obtaining the approximate solution, a class of improved MMS (IMMS) iteration methods are proposed. By suitably choosing the judgement criterion, the IMMS iteration methods do not need to solve such system of linear equations at each iteration and thus greatly improves the computing efficiency. Convergence conditions of the IMMS iteration methods are studied when the system matrices are positive definite matrices and H_+-matrices, respectively. Finally, two numerical examples are presented to show the effectiveness of the proposed IMMS iteration methods and their advantages over the existing MMS iteration methods when solving the HICP.

(Joint work with Yang Cao and Qin-Qin Shen.)

A Multi-Parameter Preconditioner for Double Saddle Point Problem Arising from Liquid Crystal Directors Modeling

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Abstract

This talk introduces a multi-parameter preconditioner for the double saddle point problem arising from liquid crystal directors modeling. We conduct a detailed analysis of the eigenvalue distribution and corresponding eigenvectors for the preconditioned matrix. As the performance of the multi-parameter preconditioner is highly dependent on parameter selection, we also derive nearly optimal values for these parameters. Numerical experiments demonstrate the superiority of the proposed preconditioner over several existing ones.

A Sparse Power Method with Extrapolation for the Higher-Order PageRank Problem

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Abstract

Higher-order Markov chain plays an important role in high-dimensional data analysis and modeling multi-relational problems. As an application, higher-order PageRank is a generalization to Google's PageRank. For this problem, the challenge is how to solve higher-order PageRank both rapidly and accurately. Extrapolation methods are effectively accelerating techniques for large-scale scientific computations. As far as we know, there are no extrapolation accelerated methods for higher-order PageRank problem. One reason is that the stationary distribution of the higher-order PageRank problem is a large-scale and dense dataset, and existing extrapolation methods cannot apply to this problem directly. Sparse higher-order PageRank generated by the sparse power method is a good alternative to higher-order PageRank, in which the dense higher-order PageRank is approximated by using a combination of a sparse component and a rank-one component. In this work, we propose a sparse power method with extrapolation. The idea is to run the extrapolation method on the rank-one component and get the weighting coefficients first, and then apply the coefficients to both the sparse component and the rank-one component simultaneously. However, the difficulty is to show why this works theoretically. To settle this problem, we demonstrate the rationality of our strategy, and prove that the proposed method can converge faster than the original sparse power method. Extensive numerical experiments on both real-world and synthetic database illustrate the efficiency of the proposed method, and show the effectiveness of our theoretical results.

A Novel Regularization Paradigm for the Extreme Learning Machine

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Abstract

Due to its fast training speed and powerful approximation capabilities, the extreme learning machine (ELM) has generated a lot of attention in recent years. However, the basic ELM still has some drawbacks, such as the tendency to over-fitting and the susceptibility to noisy data. By adding a regularization term to the basic ELM, the regularized extreme learning machine (R-ELM) can dramatically improve its generalization and stability. In the R-ELM, choosing an appropriate regularization parameter is critical since it can regulate the fitting and generalization capabilities of the model. In this paper, we propose the regularized functional extreme learning machine (RF- ELM), which employs the regularization functional instead of a present regularization parameter for adaptively choosing appropriate regularization parameters. The regularization functional is defined according to output weights, and the successive approximation iterative algorithm is utilized to solve the output weights so that we can get their values simultaneously at each iteration step. We also developed a parallel version of RF-ELM (PRF-ELM) to deal with big data tasks. Furthermore, the analysis of convexity and convergence ensures the validity of the model training. Finally, the experiments on the function approximation and the UCI repository with or without noise data demonstrate the superiority and competitiveness of our proposed models.

The Equivalence of the Randomized Extended Gauss-Seidel and Randomized Extended Kaczmarz Methods

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Abstract

The randomized Kaczmarz method, the randomized Gauss-Seidel method, the randomized extended Kaczmarz method, and the randomized extended Gauss-Seidel method are four efficient randomized iteration methods for solving large-scale systems of linear equations. In this talk, we point out that the randomized extended Gauss-Seidel method is actually mathematically equivalent to the randomized extended Kaczmarz method, and we find the intrinsic connection between the randomized-Kaczmarz-type methods and the randomized-Gauss-Seidel-type methods. In addition, by classifying a linear system into four cases according to its consistency and the column-rank of its coefficient matrix, we give the preferred method among the four randomized iteration methods in each case. With these results, we can make full use of the most appropriate randomized iteration method to solve the linear system. What is more, we can also obtain new efficient randomized iteration methods based on these analyses.

Open-Loop Nash Equilibrium for Networked Control Systems with Asymmetric Information

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Abstract

This paper focuses on the open-loop Nash equilibrium for networked control systems (NCSs) with asymmetric information. In this NCSs model, player 1 shares its observations and historical control inputs with player 2, whereas player 2 does not disclose any of its information to player 1. Using the maximum principle, we obtain an explicit analytical Nash equilibrium by decoupled solving the forward and backward stochastic difference equations (FBSDEs), while the optimal gain matrices are given by coupled Riccati equations. The asymmetric information leads to coupled forward and backward Riccati equations, which complicates the calculation. To address it, a forward iteration algorithm is employed to obtain a suboptimal solution for the open-loop Nash equilibrium strategy with asymmetric information. Numerical results illustrate that incorporating the Nash equilibrium into NCSs can improve the system performance.

Image Cartoon-Texture Decomposition by a Generalized Non-Convex Low-Rank Minimization Method

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Abstract

Image cartoon-texture decomposition is an important problem in image processing. In recent years, by exploiting low-rank priors of images, low-rank minimization methods have been widely adopted for image cartoon-texture decomposition. Since matrix rank minimization is an NP-hard problem, the convex nuclear norm is often used as a substitute for the matrix's rank to realize the low-rank minimization methods. In this paper, we utilize a generalized non-convex surrogate of the matrix rank function to develop a novel low-rank minimization model for image cartoon-texture decomposition. We design a proximal alternating algorithm to solve the non-convex model and further demonstrate the global convergence of the algorithm. Numerical experiments illustrate that the proposed method can show much better performances than the existing state-of-the-art methods for image cartoon-texture decomposition.

Minimum Residual Shift-Splitting Iteration Method for Non-Hermitian Positive Definite and Positive Semidefinite Linear Systems

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Abstract

By applying the minimum residual technique to the shift-splitting (SS) iteration scheme, we introduce a non-stationary iteration method named minimum residual SS (MRSS) iteration method to solve non-Hermitian positive definite and positive semidefinite systems of linear equations. Theoretical analyses show that the MRSS iteration method is unconditionally convergent for both of the two kinds of systems of linear equations. Numerical examples are employed to verify the feasibility and effectiveness of the MRSS iteration method.

(Joint work with Yan-Xia Dai, Kai-Hua Wang and Zheng-Cheng Zhang.)

Keywords: non-Hermitian matrix, shift-splitting, minimum residual, iteration method, convergence

Partial Trace Inequalities for Partial Transpose of Positive Semidefinite Block Matrices

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Abstract

Li (LAMA, 2023) recently obtained several improvements on some partial trace inequalities for positive semidefinite block matrices. In this talk, we present analogous partial trace inequalities involving partial transpose of positive semidefinite block matrix. The inequalities we show could be regarded as complements of Li's results. In addition, some new partial trace inequalities for partial transpose of positive semidefinite block matrix are included.

A Splitting-Based KPIK Method for Eddy Current Optimal Control Problems

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Abstract

This study presents an efficient computational framework for solving discretized linear systems in eddy current optimal control problems using an all-at-once formulation. We propose a novel Splitting-based Krylov-plus-inverted-Krylov (SKPIK) method that combines a specialized coefficient matrix splitting technique with the KPIK algorithm to achieve fast and memory-efficient solutions. The methodology involves: (1) Reformulating the discretized system into a structured matrix equation; (2) Applying iterative KPIK algorithms to obtain low-rank approximations. Theoretical analysis establishes the existence of low-rank solutions, while numerical experiments demonstrate the method's superior performance in both computational speed and storage efficiency compared to classical approaches. The SKPIK method effectively addresses the dual challenges of system size and memory constraints in large-scale sparse systems.

A New Greedy Two-Dimensional Extended Gauss-Seidel Method for Least Squares Problems

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Abstract

Building upon the Petrov-Galerkin framework and the recent 2-D randomized Gauss-Seidel (D2RGS) and 2-D randomized extended Gauss-Seidel (D2REGS) methods proposed by Mustafa and Saha for linear least-squares problems, this paper introduces a new greedy two-dimensional Gauss-Seidel method (D2GGS). Unlike D2RGS and D2REGS, which employ uniform random selection for the two-dimensional search subspace basis vectors and avoid explicit pseudoinverse computation, the proposed D2GGS method utilizes a novel greedy sampling strategy. At each iteration, D2GGS deterministically selects the two column indices corresponding to the maximum and minimum values of a specific criterion. We further extend this approach to handle rank-deficient and underdetermined linear systems, developing the 2-D greedy extended Gauss-Seidel (D2GEGS) method. Convergence properties for both new methods are established. Numerical experiments demonstrate the efficiency of D2GGS and D2GEGS. Notably, for matrices with highly coherent columns, D2GGS significantly outperforms existing Gauss-Seidel-type methods.

(Joint work with Shu-Ling Dai and Jing Zhao.)

Acceleration of the Modulus-Based Iteration Methods by Geometrically Smoothed Momentum for Solving Linear Complementarity Problems

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Abstract

In this paper, we propose to use geometrically smoothed momentum to accelerate the convergence rate of the modulus-based matrix splitting iteration methods for solving linear complementarity problem. Convergence of the proposed methods is proved when the system matrix is positive-definite or H_+ matrix. We compare the performance of the modulus-based methods with and without acceleration by geometrically smoothed momentum on a practically problem. The results demonstrate that modulus-based iteration methods with geometrically smoothed momentum acceleration converge much rapidly.

A Modulus-Based Multigrid Method for Nonlinear Complementarity Problems with Application to Free Boundary Problems with Nonlinear Source Terms

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Abstract

To overcome the dependence of the convergence rate on the grid size in the existing modulus-based method, we present a modulus-based multigrid method to efficiently solve the nonlinear complementarity problems. In this paper, the nonlinear complementarity problems under consideration arise from free boundary problems with nonlinear source terms. The two-grid local Fourier analysis is given to predict the asymptotic convergence factor and the optimal relaxation parameter of the presented modulus-based multigrid method, and the predictions are agreement with the experimental results. Numerical results also show that both W- and F-cycles significantly outperform the existing modulus-based method and achieve asymptotic optimality in terms of grid-independent convergence rate and linear CPU time when the grid is refined.

Structural Matrix-Based Resistor Network Modeling and RFNN Prediction of Node Potentials

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Abstract

The accurate computation of node potentials in large-scale resistor networks is a fundamental problem in circuit analysis, physical simulation, and engineering design. Traditional analytical approaches often become cumbersome and computationally expensive when dealing with complex boundary conditions and nonlinear interactions. In this study, two typical resistor network models are established based on structural matrices: the apple-surface resistor network and the rectangular resistor network with arbitrary boundary conditions. For both cases, exact analytical expressions of node potentials are rigorously derived. These formulas are further employed to construct large-scale, noise-free datasets that cover a wide range of network sizes, resistance ratios, and current injection points, thereby providing a solid foundation for data-driven modeling. Furthermore, an innovative Refined Fuzzy Neural Network (RFNN) learning framework is developed. The framework employs a hybrid architecture that integrates sequential and parallel learning strategies. Specifically, weighted fuzzy C-means (WFCM) clustering and weighted least squares estimation (WLSE) are executed sequentially to optimize fuzzy partitions and local regression models. This is followed by a parallel iterative process with feedforward and feedback mechanisms, which dynamically incorporates prediction errors into the refinement of cluster centers and regression parameters, enabling deep structural adjustments of the network. This iterative learning strategy not only significantly improves predictive accuracy but also enhances model interpretability by tracing the evolutionary trajectories of cluster centers and rule parameters. Extensive experiments on synthetic functions and multiple public UCI (University of California, Irvine Machine Learning Repository) datasets demonstrate that the proposed RFNN achieves superior generalization performance compared with various state-of-the-art regression algorithms. Finally, the model is applied to potential prediction in resistor networks constructed via structural matrix modeling. The predicted results closely match theoretical values, thereby validating the effectiveness of the "structural matrix modeling + data-driven learning" paradigm for accurately approximating complex potential distributions in large-scale resistor networks.

A Positive Definite and Positive Stable Splitting Iteration Method for a Class of Complex Linear Systems with Indefinite Matrix Terms

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Abstract

This paper addresses the solution of a broad class of complex symmetric linear systems involving indefinite matrix terms. By reformulating the original indefinite system into an equivalent real-valued form and applying matrix splitting techniques, we develop a positive definite and positive stable splitting iteration method. Theoretical analysis shows that the proposed method enjoys unconditional convergence and allows for the straightforward computation of theoretically optimal parameters. Extensive numerical experiments on representative model problems demonstrate the efficiency of the method in comparison with several existing approaches.

(Joint work with Jun-Lei Qin.)

Fake News Classification Using CP Decomposition and Graph Convolutional Network

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Abstract

With fake news becoming widespread on social media, its impact has become a major public concern. We construct a graph representation of news articles and employ a graph neural network for fake news classification. The proposed method utilizes local word co-occurrence information of sentences to model the interaction relationships between sentences, which are abstracted by the weight matrix of the graph. Accordingly, a third-order co-occurrence tensor is built, and the weight matrix is derived through CP decomposition of the tensor. By explicitly modeling sentence interaction patterns, the resulting representations can capture more accurate contextual information of news articles. Experimental results on two real-world datasets demonstrate that our method outperforms competing methods in both binary and multiclass classification tasks.

All Solutions of the Yang-Baxter-Like Matrix Equation $AXA = XAX$ with A Satisfying $A^4 = A$

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Abstract

In this paper, we construct some explicit solutions to the Yang-Baxter-like matrix equation $AXA = XAX$ for matrices A satisfying $A^4 = A$, thereby extending previous results in this field. By analyzing the minimal polynomial of A, we classify the problem into 11 distinct cases. Our approach leverages the Jordan decomposition of A to simplify the original equation, reducing it to a system of matrix equations involving block-diagonal matrices with smaller blocks. We then systematically solve these reduced equations to obtain the general solution. Finally, we present three numerical examples to demonstrate the applicability and effectiveness of our theoretical results.

参会代表名单

（按音序排序）

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河北师范大学简介

河北师范大学是河北省人民政府与教育部共建的省属重点骨干大学，河北省“双一流”建设一层次高校。学校起源于1902年创建于北京的顺天府学堂和1906年创建于天津的北洋女师范学堂，具有 120 多年的发展历史和光荣的办学传统。1996年6月，原河北师范大学、河北师范学院与创建于1952年的河北教育学院、创建于1984年的河北职业技术师范学院合并，组建成新的河北师范大学。2014年，河北省人民政府、教育部决定共建河北师范大学。

建校之初，河北师范大学就以革故鼎新、开启民智为使命，奠定鲜亮红色基因，积淀光荣革命传统，笃行于民族复兴伟大征程，始终同中华民族争取独立、自由、民主、富强的进步事业同呼吸、共命运。老一辈革命家邓颖超、刘清扬、郭隆真、杨秀峰、康世恩、荣高棠，著名爱国主义学者梁漱溟、张申府、汤用彤，中国科学院院士李继侗、杨应昌、严陆光、郝柏林、李树深、孙大业，中国工程院院士金国藩、刘广润、贺泓，体育界精英许绍发、蔡振华，中共十九届中央政治局常委、十三届全国人大常委会委员长栗战书等都曾在师大工作学习。从创办初期的“学堂”到今天誉满燕赵的学术殿堂，诞生于“兴教救国”时代大潮中的河北师范大学秉承“怀天下、求真知”的校训精神，薪火相传，弦歌不辍，培养了一大批致力于民族振兴、爱国报国的栋梁之才。

学校高举习近平新时代中国特色社会主义思想伟大旗帜，坚持党的全面领导，全面贯彻新时代党的教育方针，坚持社会主义办学方向，以高质量党建引领学校事业高质量发展。学校先后被省委、省政府授予基层党建红旗单位、先进基层党组织、文明单位等称号。学校获评全省党建工作示范高校，1个学院入选全国党建工作标杆院系，5个党支部入选全国高校党建工作样板党支部，1个支部入选全国高校“双带头人”教师党支部书记“强国行”专项行动团队。

学校在两个校区办学（裕华校区、红旗校区），设有23个学院（系），1个独立学院（汇华学院），现有本科专业83个，硕士一级学科学位授权点29个、硕士专业学位授权点24个，博士一级学科学位授权点11个、博士专业学位授权点1个，博士后科研流动站10个。学科专业覆盖哲学、经济学、法学、教育学、文学、历史学、理学、工学、医学、管理学、艺术学、交叉学科等12个学科门类。现有国家重点学科1个，河北省“双一流”建设学科7个、省高校国家重点学科培育项

目 1 个、省高校强势特色学科（群）4 个、省高校重点学科 14 个。学校化学、植物与动物科学、工程学等 3 个学科进入 ESI 全球前 1%。2025 年软科中国大学专业排名中，学校共 70 个专业上榜，其中 4 个专业位居全国前 10 名。

学校科学研究不断取得新进展。承担了一批国家重点研发计划，国家转基因生物新品种培育重大专项，国家发展改革委重大科技基础设施项目，国家自然科学基金重点项目、重点国际（地区）合作研究项目、区域创新发展联合基金项目、优秀青年科学基金项目，国家社科基金重大招标项目和国家清史纂修工程主体类项目等具有较大影响的科研项目。孙大业院士课题组获国家自然科学二等奖，填补了河北省的空白。

学校大力推进科研创新平台和智库建设。现有教育部重点实验室 1 个、教育部人文社会科学重点研究基地 2 个、国家语言文字推广基地 1 个、教育部省部共建协同创新中心 1 个、教育部国别和区域研究备案中心 3 个；河北省学科重点实验室、技术创新中心、工程研究中心、基础学科研究中心 20 个、人文社会科学重点研究基地 16 个、哲学社会科学重点实验室建设试点单位 1 个、国际合作基地 2 个、协同创新中心 3 个、新型智库 3 个。省部级以上科研创新平台 50 余个，服务经济建设和社会发展能力明显增强。

学校聚焦立德树人根本任务，牢记“为党育人、为国育才”初心使命，不断提高办学水平，着力培养担当民族复兴大任的时代新人。获批全国重点马克思主义学院，15 个专业通过师范类专业第二级认证，拥有国家级一流本科专业建设点 34 个、一流本科课程 21 门、人才培养模式创新实验区 1 个、特色专业建设点 6 个、专业综合改革试点项目 4 项，精品资源共享课程 6 门、精品视频公开课 1 门、精品在线开放课程 4 门，实验教学示范中心 4 个、虚拟仿真实验教学项目 1 项、专业学位研究生培养实践基地 3 个，中国专业学位案例中心案例库收录教学案例 36 篇；省级一流专业建设点 31 个、一流本科课程 47 门、本科教育创新高地 7 个、品牌特色专业 8 个、专业综合改革试点项目 5 项、精品在线开放课程 18 门、虚拟仿真实验教学项目 12 项、课程思政示范课程 9 门、实验教学示范中心 5 个、虚拟仿真实验教学中心 2 个、研究生课程思政示范项目 28 项、研究生课程思政教学研究示范中心 4 个，研究生示范课程 79 门、专业学位研究生教学案例（库）79 项、研究生教学改革研究项目 11 项。学校获评“全国毕业生就业典型经验高校 50 强”“全国五四红旗团委”，冬奥志愿服务团队被党中央、国务院授予“北京冬奥会、冬残

奥会突出贡献集体”，入选教育部首批深化创新创业教育改革示范高校、“卓越中学教师培养计划”改革项目实施院校。近年来，共获得6项国家级教学成果奖（一等奖1项，二等奖5项）。

学校建立了涵盖学前教育、基础教育、高等教育、职业教育、民族教育、特殊教育“六教并重”的全学段、全学科教师教育体系。深入开展顶岗实习支教工程，有效服务农村基础教育发展，助力乡村振兴。设有全国中小学骨干教师培训基地、全国重点建设职业教育师资培训基地、教育部高校辅导员培训和研修基地、河北省职业教育研究所、教育科学研究所、学科教育研究所、河北省中小学教师继续教育中心、河北省高等学校师资培训中心、河北省高校现代教育技术中心、中国教育科研网河北省主节点等机构。学校紧盯时代发展前沿，抢抓人工智能发展机遇，获批教育部“人工智能助推教师队伍建设”“5G+智慧教育”“人工智能教育研究与应用中心”建设项目，助力我省教师教育模式变革和高质量发展。面向社会需求发展非师范专业，形成了师范专业与非师范专业共同发展的人才培养新格局。

学校现有在职教职工2632人，其中专任教师1662人。在职教职工中，正高职人员386人，副高职人员921人。拥有全国高校黄大年式教师团队2个、国家级教学团队1个、国家高层次人才10人，国务院政府特殊津贴专家18人、国家“百千万人才工程”入选者、国家有突出贡献的中青年专家2人，省级以上各类优秀专家204人次。

河北师范大学坚持高水平开放合作，和200多所国外大学开展交往。多年来积极开展留学生本、硕、博学历及汉语语言教育，是“中国政府奖学金”和“国际中文教师奖学金”项目接收单位。建有4所孔子学院、1所葡中双语高中、1所海外学院、2所海外预科学院，向20多个国家选派国际中文教育志愿者。现有中外合作办学项目2个，自2021年起获批教育部中外人文交流中心高层次国际化人才培养创新实践项目，积极参与全球教育治理。

进入新时代，开启新征程。全校上下正以党的二十大精神为指引，全面贯彻落实学校第九次党代会提出的任务，聚焦“双一流”和省会高水平大学建设目标，凝心聚力、开拓创新，踔厉奋发、笃行不怠，不断开创高水平综合性师范大学建设新局面，为奋力谱写中国式现代化建设河北篇章、实现中华民族伟大复兴作出新的更大贡献。

河北师范大学数学科学学院简介

河北师范大学数学科学学院的起源有三个分支，即原河北师范大学数学系、原河北师范学院数学系、原河北教育学院数学系。原河北师范大学数学系成立于1950年初，是从天津河北师范学院理化系分立发展起来的，1956年8月迁至石家庄，建立石家庄师范学院数学系，1962年更名为河北师范大学数学系。河北师范学院数学系发端于1951年河北师范专科学校的数学科，1956年更名为河北北京师范学院数学系，1961年北京铁道师范学院数学系并入，1969年迁至张家口宣化后，更名为河北师范学院数学系，1981年随原河北师范学院迁至石家庄市。河北教育学院数学系成立于1986年。1996年四校合并成立新的河北师范大学，1998年11月原河北师范大学数学系、原河北师范学院数学系、原河北教育学院数学系合并成立了河北师范大学数学系，2000年1月与计算机系合并组建数学与信息科学学院。2019年4月，计算机系从数学与信息科学学院分离并入计算机与网络空间安全学院后，数学与信息科学学院于2019年10月更名为数学科学学院。

河北师范大学数学学科是上世纪80年代初我国正式建立学位制度后首批获得硕士学位授予权的学科，1998年和2006年分别获得基础数学和应用数学博士学位授予权，2007年设立博士后科研流动站，2011年获批博士学位授权一级学科，是目前河北省首个的数学学科博士学位授权点。多年来，在河北省及学校的重点建设下，数学学科得到了长足发展。2005年数学学科入选河北省强势特色学科，2013年被确定为河北省高校国家重点学科培育学科，2016年被确定为河北省“双一流”建设世界一流学科建设点。在教育部公布的全国第四轮学科评估结果中，数学学科进入B类学科，并在第五轮学科评估中取得新突破，实现提档升级。数学学科在推进学术发展的同时积极服务社会需求，建立了基础理论研究、应用研发等多个平台，目前拥有河北省基础数学基础学科研究中心、河北应用数学中心、河北省计算数学与应用重点实验室、河北省数字教育协同创新中心、河北省数学与交叉科学国际联合研究中心、河北省外国院士工作站等省级科研平台。此外，河北省数学会也挂靠在我院。

数学学科建有算子代数与算子理论、智能计算及应用、组合数学、微分方程与动力系统、控制论与运筹学等特色研究团队，近五年主持国家级项目58项，

其中包括国家自然科学基金重点项目、国际（地区）重点合作项目和优秀青年基金项目各 1 项。承担省部级项目 50 项，获首届基础科学前沿科学奖 1 项、河北省燕赵友谊奖 2 项、河北省科学技术合作奖 1 项、河北省自然科学二等奖 1 项、三等奖 2 项；举办高水平国际和全国性学术会议 46 次。在科学研究方面，数学学科创造了多项学校第一：首次获批国家自然科学基金优秀青年基金项目，首次引进海外高层次人才计划入选者，首次引进国家优秀青年科学基金项目获得者，获得了唯一一篇全国优秀博士学位论文。

数学科学学院是河北省中学数学师资的重要人才培养基地，多年来一直保持高质量的育人传统，在本科教育和研究生教育方面成果显著，人才辈出。目前，数学学科设有数学与应用数学、应用统计学和数据计算及应用三个本科专业，年招收本科生 510 余人，其中数学与应用数学专业是国家级一流本科专业建设点；数学一级学科每年招收博士研究生 20 余人、硕士研究生 100 余人。学院每年为国内外科研院所输送博士、硕士研究生百余人，其中，许多已成为国内外高校和科研机构的骨干力量。国家杰出青年基金获得者、山东大学副校长刘建亚，国家杰出青年基金获得者、北京师范大学教授李增沪，国家杰出青年基金获得者、北京大学教授刘培东，中国数学会第十二届理事会副理事长、南开大学教授郭军义，第七届国务院学位委员会数学学科评议组秘书、北京大学教授冯荣权，国家杰出青年基金获得者、中国科学院地质与地球物理研究所研究员王彦飞，河北省人大常委会副主任、民进河北省委主委张妹芝，中国燃气控股有限公司总裁刘明辉等都是我校数学专业的优秀毕业生。目前，在河北省基础教育领域，数学学科毕业生中有百余人担任校级领导职务，特级教师及正高级教师百余人。

学院现有专任教师 91 人，其中正高职称教师 29 人，副高职称教师 36 人，全职外籍教师 3 人，具有海外经历教师 34 人。教师团队中有 ICM45 分钟报告人 1 人、国家级人才 4 人、国务院特殊津贴专家 2 人、中国数学会副理事长 1 人、教育部新世纪优秀人才 2 人、中科院百人计划 1 人。聘请外籍客座教授 9 人，其中外籍院士 2 人。“数学与数据科学教师团队”入选第四批“全国高校黄大年式教师团队”创建示范活动入围名单。

在基础研究取得丰硕成果的同时，应用研究也取得了突破性进展。依托数学学科，通过校企合作方式创建了软件学院、物联网研究院，为数学与信息、地理以及电子等学科的交叉融合提供了平台。2013 年获批了河北省第一个面向教育技

术领域的协同创新中心——“河北省数字教育协同创新中心”。2015年该中心申报的“智慧城市与教育公平”荣获第五届巴塞罗那智慧城市博览会暨全球峰会全球智慧城市项目大奖，成为我国唯一获此殊荣的项目；开发的E•School教育产品，通过“教”与“学”方式的数字化、网络化变革，有力推动了基础教育领域改革和教育公平，目前已被河北省教育厅在24所中小学试用。目前，学院承担了“北太天元”国产通用型科学计算软件—图像处理工具箱研发项目的研发工作，独立研发3个行业工具箱并正式对外发布，成为首家独立完成工具箱研发并取得自主知识产权的联合研发单位，为解决基础软件“卡脖子”问题做出了贡献。