Neural Networks, Dynamical Systems, Control Families, and Formal Languages

Linking causal and structural connectivity in pulse-output nonlinear networks

The causal connectivity of a network is often inferred to understand network $\begin{array}{ccc} \textbf{IF} \hspace{0.2cm} \square \hspace{0.2cm}$ causality measure one applies, and it may differ from the network's underlying \Box structural connectivity. However, the interpretation of connectivity \Box connectivity \Box be fully clarified, in particular, how causal connectivity depends on causality measures and and connective connectivity on the connection of the connection of the connection of the connectivity of the connectivity of the connectivity of the connectivity of the connectivity. Here, we focus on the connectivity nonlinear networks with pulse signals as measured output, e.g., neural networks with spike output, and address the above issues based on four commonly utilized causality \Box i.e., time-delayed correlation coefficient correlation, time D causality causality, and the transfer entropy. We then the causality of the causa measures are related to one another when applied to pulse signals. Taking a simulated Hodgkin–Huxley network and a real mouse brain network as two illustrative examples, we further verify the quantitative relations among the four causality measures and dellate that the coincides with the coincides with the four with the four well coincides with the four with th the underlying network structural connectivity, therefore illustrating a direct link between the causal and structural connectivity. We stress that the structural connectivity of pulse-output networks can be reconstructed pairwise without conditioning on the global information of all other nodes in a network, thus circumventing the curse of dimensionality. Our framework provides a practical and effective approach for pulseoutput network reconstruction.

 \Box

 \Box

 \Box

 \Box \Box

 \Box

Bound-Preserving OEDG Schemes for Aw-Rascle-Zhang Traffic Models on Networks

 P Physical solutions to the widely value and P the adapted pressure (AP) ARZ model should satisfy the positivity of density, the minimum and maximum principles with respect to the velocity v and other Riemann invariants. Many numerical schemes suffer from instabilities caused by violating these bounds, and the only existing bound-preserving (BP) numerical scheme (for ARZ model) is random, only first-order accurate, and not strictly conservative. This paper introduces arbitrarily high-order provably BP discontinuous Galerkin (DG) schemes for these two models, preserving all the aforements are models and the maximum to maximum the maximum to maximum t
The maximum to maximum principle of v, which has been rigorously proven to conflict with the consistency and conservation of numerical schemes. Although the maximum principle of viewers. Although the maximum principle o directly enforced, we find that the strictly preserved maximum principle of another Riemann invariant w actually enforces an alternative upper bound on v. At the core of this work, and rigorously proving the BP property is a particularly property in \Box T of C of C is the Lass–Friedrich property in the space T conservation and and enperture to construct BP schemes, and a construct BP schemes, does not hold for the two models. To overcome this challenge, we formulate a generalized version of the LF splitting property, and prove it via the geometric quasilinearization (GQL) approach. To suppress spurious oscillations in the DG solutions, we incorporate the oscillationelimination of the solution of a novel damping on the solution of a novel damping of a novel damping of a nove equation. Several numerical examples are included to demonstrate the effectiveness, A and properties of our states of our states of A road networks. \Box \Box

个人简介:陈威,厦门大学博士二年级在读,2021 年本科毕业于福州大学, ~ 0

 G define M defined G defined P defined \mathbb{P} defined \mathbb{P} defined \mathbb{P} defined by G defined by G defined by G defined by G defined by \mathbb{P} defined by \mathbb{P} defined by \mathbb{P} defined by \sim 1 \Box

样问题和数据生成问题,设计对应的高效计算格式,并给出适定性和收敛性分析。 $J \quad J$

, and the state of the sta \Box \Box \Box 个人简介:丁钊。2020 年本科毕业于武汉大学数学与统计学院数学基地班,

 \Box \overline{a}

 $\Box\quad \Box \qquad \Box$

 AD

 \Box \Box

 \Box \Box \Box \Box \Box \Box \Box $\overline{\square}$

 AD

AD

T BKL 明以上格式具有二阶精度、对称和不振荡的优良性能。 \Box \Box 个人简介:北京应用物理与计算数学研究所 2022 级博士生,导师为成娟研

 \Box \Box \Box \Box \Box \Box \Box \Box

Probabilistic error analysis of CholeskyQR based on columns

NO **de algorithms are very popular in both a** recent years. It could make a balance between the computation of \Box and contain the computational containing \Box and c speed. CholeskyQR2 provides numerical stability of orthogonality and Shifted NOO deals deals regarding \Box deals \Box deals the matrices. \Box is defined as \Box in the matrices. \Box is defined as \Box is defined as applicable for sparse matrices. However, the overestimation of the error matrices in the previous works in the sufficient conditions for the sufficient conditio leads to a conservative shifted item in Shifted CholeskyQR3 and 3C, which may greatly influence the properties of the algorithms. In this work, we consider the randomized methods and utilize the model of probabilistic error analysis of Nick Higham to do rounding the combine and computed the type algorithms. The top combine the theoretical combine the theoretical combine the top combine the to analysis with the provide in the group work. Our analysis work work and an our and provide and and and provide
The provident provident provide and provide and provide and provide and and provide and provide and and provid smaller shifted item for Shifted CholeskyQR3 and could improve the orthogonality of our 3C algorithm for dense matrices. Numerical experiments in the final section shows that our improvements with randomized methods with randomized methods and the some advantages compared methods
The some advantages compared methods and advantages compared methods compared methods and advantages compared with the original algorithms. \Box

\Box

Ψ, 2020 a, 2020 ä, 2020 a, 20
Γεννή εκπαιδία της επιτροπής επιτροπής της επιτροπής της επιτροπής της επιτροπής της επιτροπής της επιτροπής τ

A positivity-preserving finite difference scheme for the Flory-Huggins-Cahn-Hilliard equation with dynamical boundary condition

We proposed and analyzed a finite difference numerical scheme for the Flory- \texttt{E} is the different value of \texttt{Q} different values of \texttt{Q} dif evolution equation for the boundary profile corresponds to a lower-dimensional logarithmic energy potential. In turn, a theoretical analysis for the coupled system becomes very challenging. In the numerical design, a convex splitting approach is applied to the chemical potential potential potential potential associated with the energy in both bulk and bu
The energy in both bulk and b $\Box C$. Finite approximation and convexity and convexi numerical system could be represented as a minimization of a discrete convex $\mathbb Q$ die singularity factor from a prevents the solution from a probability from a probability for a probabilit points and ensures the unique solvability. The total energy stability analysis could be fulfilled by an estimate over the finite difference inner product. In addition, an \$H^{- 1}\$ convergence analysis is established via a carefully designed correction function. Some numerical results are presented, which demonstrate the robustness of the \Box scheme. \Box \Box

 \textbf{J} , and \textbf{J} , and \textbf{J} , and \textbf{J}

A phase field model for deformation-induced amorphization

Amorphization due to severe plastic deformation has been discovered in various crystalline materials. Despite its importance, developing a rigorous and general theory of strain-induced amorphization remains entries and interior remains elusive due to the interior modelling and
Interior and interior due to the interior modelling and interior modelling and interior modelling and interior microstructural changes and deformation mechanisms. In this study, we propose a novel model integrated with elastic-plastic theory to shed light on shear-induced amorphization in nanocrystalline alloys. Our model incorporates the martensitic transformation of the australian of the australian of the australian plastic deformation, followed by the australian of the australi intensification of crystal fracture on the martensite phase to form an amorphous phase. \mathbf{P} , and anorphous nucleation is morphous nucleation in the stress of the s regions, such as shear bands, and that the critical plastic strain for amorphization increases as grain size enlarges. These observations align with experimental data, indicating that our phase-field model captures the physical picture of shear-induced amorphization and can predict the threshold for amorphization. Overall, our work offers valuable insights into shear-induced amorphization and paves the way for enhancing the understanding of amorphous materials and fostering the development of more precise and comprehensive models for investigation. $\hfill \square$

 ~ 0

 \Box

 E HMP Γ

 T $J \Box$ - 1 \Box \Box \Box \Box \Box \Box \Box \Box \Box

 \mathcal{M}_c and \mathcal{M}_c and \mathcal{M}_c and \mathcal{M}_c and \mathcal{M}_c and \mathcal{M}_c and \mathcal{M}_c

Natural model reduction for kinetic equations

Numerical simulation of kinetic equations poses significant challenges due to their inherently high-dimensional nature. This talk introduces a novel geometric approach to achieve model reduction while preserving essential structural properties of the equations under certain conditions. By employing projections onto tangent bundles of finite-dimensional approximate solution manifolds, our framework naturally yields first-order hyperbolic systems. We introduce criteria for selecting Riemannian metrics for kinetic equations, which act as analogues of symmetrizers for first-order PDEs, ensuring hyperbolicity and linear stability. Furthermore, we establish, for the first time, Γ a rigorous connection between the H-theorem for kinetic equations and the linear \Box and \Box \Box \Box \Box \Box \Box \Box \Box . \Box 个人简介:金则宇是北京大学数学科学学院计算数学专业 2021 级博士研究 生,师从李若教授。他于 2021 年获得北京大学学士学位,其研究方向为微分方 $R = 1$ \Box \Box \Box \Box \Box \Box \Box \Box $\hfill \square$ \Box \Box

Feature Averaging: An Implicit Bias of Gradient Descent Leading to Non-Robustness in Neural Networks

Fin this work, we investigate a particular investigate a particular in the gradient of the gradient descent of training process, which we ten in the process of the international process, which we have the international process, which we have the term in the ter principal factors contributing to non-robustness of deep neural networks. Despite the existence of multiple discriminative features capable of classifying data, neural networks trained by gradient by gradient by gradient descent by gradient deserties and anticombination) of these features, rather than distinguishing and leveraging each feature individually. In particular, we provide a detailed theoretical analysis of the training die die die two-layer des die two-layer van die two-layer van die two-layer van die two-layer van binary classi
Die van die two-layer van die two-laye task, where the data distribution consists of multiple clusters with orthogonal cluster center vectors. We rigorously proved that gradient descent converges to the regime of the regime of the regime
The regime of the regime o feature averaging, wherein the weights associated with each hidden-layer neuron represent an average of the cluster centers (each center corresponding to a distinct Feature is a network classifier to be network classifier to an attack the network classifier to an attack the
The network of a classifier to an attack that a classifier to an attack the substitution of a classic problem the negative direction of the averaged features. The averaged features in the average of the averaged features provision of more granular supervised information, a two-layer multi-class neural network is capable of learning inducer is able to induce a binary inducer inducer inducer and induce a binary
The inducer is able to induce a binary is able to induce a binary is able to induce a binary is able to induce classifier with the optimal robustness under our setting. Besides, we also conduct extensive experiments using synthetic datasets, MNIST and CIFAR-10 to substantiate the phenomenon of feature averaging and its role in adversarial robustness of neural networks. We hope the theoretical and empirical insights can provide a deeper und of the impact of the interest of the interest of t
In the contract of the impact of the impact of the impact of the impact of the interest of the interest of the
 which in turn influences the robustness of the network, and how more detailed supervision may enhance model robustness.

 \Box

 202

Function and Derivative Approximation by Shallow Neural **Networks**

 $T \Box$ investigate a Tikhonov regularization specifically tailored for specifically tailored for shallow \Box or shallow \Box in \Box networks with the context of $\mathcal I$ and $\mathcal I$ and $\mathcal I$ and $\mathcal I$ unkanown function and its derivatives in a unit cubic domain and its derivatives in a unit cubic domain based
The unit cubic domain based on noisy and its derivatives in a unit cubic domain based on noisy and a unit cubi measurements. The proposed Tikhonov regularization scheme incorporates a penalty term that the term that the term three distinct yet interestinct we have the semi-metal semi-metal of the extend
The extended network (semi-metal of the extended network (semi-metal of the extended network (semi-metal of t Barron norm, the variation norm, and the Radon-BV seminorm. These choices of the penalty term are contingent upon the specific architecture of the neural network being utilized. We establish the connection between various network norms and particularly trace the dependence of the dimensionality index, aiming to deepen our understanding of how the norms interpreted the universality of the universality of the universality of the universality of t
The universality of the univers approximation through various norms, establish rigorous error-bound analysis for the Ω die deposition scheme, and explicit the dependency of the dependency of the dependency of the dependency of the deposition of the dependency of dimensionality index, providing a clearer understanding of how the dimensionality affects the approximation performance and how one designs a neural network with diverse approximating tasks. \Box

 \Box

 $\mathbf K$

From Generalization Analysis to Optimization Designs for State Space Models

 $F \Box \Box$) $F \Box \Box \Box \Box \Box \Box \Box \Box \Box$ of $P \Box \Box \Box \Box \Box \Box \Box \Box \Box \Box$ analysis and their potential as an alternative to transformers for sequence modeling. I \square introduce the generalization theory of \square introduce in \square in these models are trained. By examining the connection between SSM parameters and the temporal patterns in the temporal patterns in the temporal patterns in the model of model and model in the
The temporal patterns in the model of model and model in the model of model and model in the model of model an initialization that improves the consistency of SSM outputs across various data patterns, and (2) introduce a new training regularization method to enhance model performance. These insights offer practical benefits for using SSMs effectively in sequence modeling \Box \Box

Low-rank optimization on Tucker tensor varieties

Interface Laplace Learning: Learnable Interface Term Helps Semi-Supervised Learning

We introduce a novel framework, called Interface Laplace learning, for graphbased semi-supervised learning. Motivated by the observation that an interface should exist between die staan die value is non-smootheid van die value is non-smootheid van die value is noor van di
Die value is non-smootheid value is non-smootheid van die value is non-smootheid van die value is non-smoothei Laplace learning model that incorporates an interface term. This model challenges the long-standing assumption that functions are smooth at all unlabeled points. In the proposed approach, we add an interface term to the Laplace learning model at the interface positions. We provide a practical algorithm to approximate the interface positions using k-hop neighborhood indices, and to learn the interface term from labeled data without artificial design. Our method is efficient and effective, and we present extensive experiments demonstrating that Interface Laplace learning achieves better performance than other recent semi-supervised learning approaches at extremely low \Box \Box \Box KFPQ) \Box KFPQ) \Box ECO.- \Box \Box \Box 个人简介:王汤军,于 2020 年在清华大学数学系获得理学学士学位,目前

Discontinuous Galerkin methods for the steady-state solutions of Euler equations

In the realm of steady-state solutions of Euler equations, the pursuit of residue convergence to machine precision has been a persistent challenge for high-order shockcapturing schemes, especially in the presence of intense shock waves in the presence of intense shock waves. T
This is a contracted that in the presence of intense shock was also that in the presence of intense shock was challenge, we have introduced a hybrid limiter within the framework of discontinuous D methods. The integration integrates the integrates the jump indicator in the jump indicator and limiter integrates the jump indicator in the jump indicator and limited variables the jump indicator and limited variable components seamlessly, yielding a more cohesive and efficient approach. For steadystate problems, we have utilized the hybridization of the DG solution with the cell average, eliminating the necessity for characteristic decomposition and intercell communication, thereby significantly reducing computational costs and enhancing parallel efficiency. Additionally, we have developed a novel jump filter, which operates locally based on jump information at cell interfaces, targeting high-order polynomial modes within each cell. This filter not only retains the localized nature but also preserves the key attributes of the DG method, including conservation, L2 stability, and high-order accuracy. We have also explored its compatibility with other damping techniques and demonstrated its seamless integration into a hybrid limiter. Numerical experiments are presented to illustrate the robust performance of these schemes for steady Euler equations on both structured and unstructured meshes. \Box

 \Box

 $\Box G$ \Box \Box $\Box M$ \Box \Box \Box \Box \Box \Box \Box \Box \Box \Box

Phase field based thermal--fluid topology optimization method

 $F \Box \Box$) \Box and $\Box QM$ $P \Box$ based to \Box based to \Box to \Box to \Box to \Box to \Box for \Box for the hydrodynamical and convective heat transfer, which can optimize the channels shapes to maximize the heat loss and mass flux by holding the constant mean curvature. The constant mean curvature. The constant mean curvature of the constant mean curvature. The constant mean curvature of the constant me The fluids channels with non-trivial geometries freely evolve along the optimization process the TPMS-based assumption. We provide a new proposed assumption. We propose a new proposed a new proposed a new proposed a new proposed and a new proposed modifying the original energy equation based on the constant curvature property of the OM posed to a novel government composed of the \Box \Box the Darcy–Stokes model, the Darcy–Stokes model, and the convection–diffusion–diffusion–diffusion–diffusion–diffusion–diffusion–diffusion–diffusion–diffusion–diffusion–diffusion–diffusion–diffusion–diffusion–diffusion The Crank–Nicolson method with second order time accuracy and the central difference method with second order space accuracy were utilized to discretize the system. The Lagrange multiplier method was applied to avoid the influence of higher-order nonlinear terms and highly coupled terms on the stability of the proposed scheme. It was proved that the system satisfied the unconditional energy dissipation of the original energy in both continuous and discrete cases, which in the continuous and discrete cases, which in the large-s
The continuous and discrete cases, which in the continuous and discrete cases, which in the continuous and dis computation and large time steps can be performed. We performed various numerical experiments and carried out to pology optimization based on \Box structure with different porosity, types, and sizes, which demonstrated that the fluid channel with optimized structures can greatly in the original transfer than the original transfer than the ori QMP **de de la partitative and quantitative and quantitative and quantitative and qualitative perspective perspective perspective perspective and qualitative perspective perspective perspective and qualitative perspective p**

- \Box
- \Box

 $0A$ $\mathbf{P} = \mathbf{1}$ 三完成人) ,西安交通大学"2022 年度优秀研究生标兵(个人最高奖) 等多项 J J B)G MMC $\bf C$ and $\bf FM$ are $\bf BPF$ and $\bf BPF$ are $\bf CPF$ \Box \Box \Box \Box

Weak Galerkin finite element method for interface problems with curved interface

 $F \Box \Box \Box \Box \Box \Box \Box \Box \Box$ in the weak \Box finite \Box fi interface problems with curved interface. When solving such problems on fitted meshes, the geometric error introduced by a proximating the curve interface with straight and a straight and a straigh
The curve interface with straight and a straight straight and a straight and a straight and a straight and a s segments limits the accuracy of high-order numerical methods. To overcome this challenge, we directly construct the WG space on curved interface elements, thus avoiding geometric error. To demonstrate the effectiveness of this method, we apply it to the Stokes interface problem as an example. However, this method may become inefficient for problems with moving interfaces, as the mesh has to be updated to capture the evolving interface. Therefore, we consider solving interface problems on N Q Q LEMET (NON-interface) our method in non-interface interfaces are used in non-interface in non-interface elements, while immersed weak function spaces that exactly satisfy interface conditions are entropy in the interface in the interface in the interface $\mathbb Q$ interface interface interface in the interface in constructed to maintain optimal approximation properties. At the same time, the proposed numerical scheme achievem achievem achievem achievem $\Box Q$. The $\Box Q$ of \Box \Box \Box \Box \Box \Box \Box

A fast numerical scheme for fractional viscoelastic models of wave propagation

Te propose a fast scheme for a fast scheme for a fast scheme for a fast scheme function by an approximation by an approximation by an approximation by a fast scheme for a fast scheme for a fast scheme function by an approx efficient sum-of-exponentials (SOE), and apply the sum-of-exponential model of the scheme to the viscoelastic model of the scheme to the scheme to the scheme to the viscoelastic model of the scheme to the viscoelastic mod wave propagation with mixed finite element methods for the spatial discretization and \mathbb{R} scheme for the second-order temporal derivative. Compared with \Box the second-order temporal derivative. Compared with \Box traditional derivative, our fast scheme for fast scheme for fast scheme for fast scheme for fast scheme reduce
The memory of the memory o $\square \quad \square \quad Y \qquad \square L\ \textrm{K}\quad \textrm{K}\quad \square \quad \square \quad Y \qquad \square L\ \textrm{K}\quad \textrm{K} \qquad \square \quad \square \quad \square$ \square \square \square Υ \times \times \square \square \times \times \times \square $\Box K$ denotes the total number of the temporal grid points, $\Box K$ is the number is the number \Box of exponentials in SOE, and \$N_s\$ represents the complexity of memory and computation relation relationships are provided to the spatial discretization. Numerical experiments are provided to the spatial discretization of the spatial experiments are provided to the spatial discretization. Numeri to verify the theoretical results. \Box

Selective focusing of multiple particles in homogeneous and layered medium

Inverse scattering of multiple well-separated particles has a wide range of \mathbf{p} and applications highly challenging due to the multiple scattering \mathbf{p} $\Box \Box \Box \Box \Box \Box \Box \Box \Box \Box$ this imaging problem, enabling selective focusing on each particle using far field $\mathbb Q$ deast as ymptotic analysis of the time reversion \Box properties of oscillatory integrals, we establish a relationship between the eigenführt of the time reversal operator and the time reversal of the particles in the particles in the particl
The particles in the part homogeneous and layered medium. Specifically, we show that under suitable conditions, each particle with various boundary generates several significant eigenvalues with the corresponding eigenfunctions producing incident waves that focus selectively on the associated particle. Application of this method to imaging particles with multiple scattering effect is demonstrated through boundary integral formulations. \Box \Box

Stability of Least Square Approximation under Random Sampling

- This paper investigates the stability of the least squares approximation P_m^n within the univariate polynomial space of degree m, denoted by P_m. The $\Box M$ entails in P \Box entails in P \Box and \Box in P_m that approximates a polynomial in P_m that approxim function f over a domain X based on samples of f taken at n randomly selected points, a specified to a specified measure. The primary goal is to determine the primary goal is to determine the sampling rate necessary to ensure the stability of P_m^n. Assuming the sampling points are i.i.d. with respect to a Jacobi weight function, we present the sampling rates that guarantee the stability of P_m^n. Specifically, for uniform random sampling, we demonstrate that a sampling rate of n \asymp m^2 is required to maintain stability. By integrating these findings with those of Cohen-Davenport-Leviatan, we conclude that, for uniform random sampling rate of \Box the optimal sampling rate for \Box in the stability of \Box is \Box in $\Box Y$ den den den voorbeeld bedeur van de log(n) factor. Motivated by the extending terms result, we extend impossibility theorem, previously applicable to equally spaced samples, to the case of random samples, illustrating the balance between accuracy and stability in recovering analytic functions. \Box
	- \Box
- $\mathbf{1}$ 2024 $\mathbf{1}$