vergence and linear complexity of the method.

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PP5

Likelihood Approximation with Hierarchical Matrices for Large Spatial Datasets

In this work we use available measurements to estimate unknown hyper-parameters (variance, smoothness parameter and covariance length) of the covariance function. We do it by maximizing the joint log-likelihood function. To overcome cubic complexity in the linear algebra, we approximate the discretized covariance function in the hierarchical (H-) matrix format. The H-matrix format has a log linear computational cost and storage O(knlogn), where the rank k is a small integer and n is the number of locations. Previous results show that the H-matrix technique is very robust for approximating the matrix itself, its inverse, its Cholesky decomposition and the Schur complement (conditional covariance). Other motivating factors for applying H-matrix techniques are: [i] The class of H-matrices is more general than other classes of matrices; [ii] The H-matrix technique allows us to compute not only matrix-vector products, but also quite general classes of functions, such as inverse, LU decomposition, determinant, resolvents, and many others; [iii] H-matrices are relatively new, but already a well studied technique; [iv] Approximation accuracy is fully controlled by the rank. Full rank (k=n) gives an exact representation; [v] Keep advantages after matrix operations, such as computing conditional covariance matrix (Schur complement can be again approximated in the H-matrix format).

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PP5

Evaluation of An Improved Numerical Technique for Solving the Hypersonic Boundary Layer/Shockwave Interaction Problem

This work demonstrates the robustness and effectiveness of the scheme introduced by [Elamin Gafar, The Integral-differential Scheme (IDS): A New CFD Solver for the System of the Navier-Stokes Equations with Applications, 2008] referred to as the *Integro-Differential Scheme* (IDS). IDS merges the traditional differential and integral representation of the conservation equations. This scheme is built on the premise that the numerical control volume, cell and nodes are hardwired and, the temporal fluxes are obtained through a consistent averaging procedure. The problem of interest to this study is the hypersonic boundary layer/shockwave interaction problem. The Mach number was 5.0, the Reynolds number based on the length of the plate ($Re_{\infty L}$) was in the order of 10^6. The numerical solution is obtained by solving the two-dimensional compressible Navier-Stokes equations (NSE) using an explicit formulation. Parametric studies indicate that the scheme reproduce accurately the flow features for a wide range of problems and conditions. Unlike other schemes, this method is independent of the mathematical classification of the flow, allowing us to implement a wide range of boundary and initial conditions without tweaking the scheme. This feature highlight the potential of this scheme to solve a variety of fluid dynamics problems with the same numerical method.

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PP5

Experiences, Optimizations, and Future Directions with Petsc on the 2nd Generation ("Knights Landing") Intel Xeon Phi Processor

As the high-performance computing community pushes towards the exascale horizon, power and heat considerations have driven the increasing importance and prevalence of fine-grained parallelism in new computer architectures. The Intel Many Integrated Core (MIC) architecture utilizes many small, low power x86 cores within a single Intel Xeon Phi processor to achieve power-efficient high performance. The second generation ("Knights Landing") Intel Xeon Phi Processor offers a very high degree of parallelism in a single, bootable CPU, with up to 72 cores (288 hardware threads), each of which has two vector processing units supporting 512-bit SIMD operations. It also incorporates very high-bandwidth on-package memory, which facilitates good utilization of those cores when working with assembled sparse matrices. The high degree of fine-grained parallelism and more complicated memory hierarchy considerations of such "manycore" processors present some challenges to existing scientific software. Here, we consider how the widely-used Portable, Extensible Toolkit for Scientific Computation (PETSc) can best take advantage of such architectures. We will discuss some key architectural features of the Intel Xeon Phi, relate experiences drawn from a variety of application areas using PETSc on it, discuss ongoing code optimization and algorithmic development work, and outline possible ways that PETSc should evolve to best utilize this and future manycore architectures.

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PP5

On An Inverse Diffusion Coefficient Problem Arising in Geochronology

We consider a problem arising in geochronology, a branch of geology which deals with the dating of rock formations and geological events. In particular, we investigate the reconstruction of temperature histories of rocks by solving a time-dependent inverse diffusion coefficient problem for parabolic partial differential equations with an integral overspecification. We show the existence and uniqueness of classical solutions using fixed point theory. Our numerical algorithm employs the implicit Euler method with variable time step and a finite element discretization in space. We present some numerical results including the errors and convergence rates to illustrate the accuracy of the proposed algorithm.

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PP5

An Effect of Turbulence on Zonal Jet Flows in Forced 2D and Quasi-Geostrophic Shallow Water Models on a Beta Plane

In randomly forced two-dimensional Navier-Stokes turbulence on a rotating sphere, it is known that a multiple zonal-band structure, i.e. a structure with alternating eastward and westward jets, emerges in the course of time development. The multiple zonal-band structure then experiences intermittent mergers and disappearances of zonal jets, and a structure with only a few large-scale zonal jets is realised as an asymptotic state (Obuse et al., 2010). With the view of understanding the long-time behaviour of the zonal jets, especially the merging and disappearing processes of the zonal jets, Obuse et al. (2011) considered large-scale zonal flows superposed upon a homogeneous zonal flow and a small-scale sinusoidal transversal flow on a beta plane, which was originally introduced by Manfroi and Young (1999), then discussed the merging and disappearing processes of zonal jets by investigating the linear stability of analytical steady isolated zonal jet solutions. In this talk, we extend the Manfroi-Young model by taking account of the spatial variation of the disturbance in the zonal direction, and the surface variation of fluid layer, in order to make the model a little more realistic. The linear stability analysis of analytical steady isolated zonal jet solutions suggests the instability of zonal jets due to back-ground turbulence effect is widely common on beta plane.

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PP5

A Computational Model for Sound Source Recognition

Hearing is an important part of normal human interaction, yet we understand surprisingly little about how our brains make sense of sound. The ability of a normal human listener to recognize objects in the environment from only the sounds they produce is extraordinarily robust with regard to characteristics of the acoustic environment and of other competing sound sources. Robust listening requires extensive contextual knowledge, but the potential contribution of sound-source recognition process has largely been neglected by researchers. As a stepping stone for an artificial listener, a computational model was developed to recognize