Thursday afternoon 7 October

14:15 - 15:00 Hour  One-minute session (for presenting poster)
Line-up (alphabethic order, see booklet)
Room 27/28

15:00 - 16:30 Hour  Poster session, incl. coffee/tea
Room 27/28/29
Residual and Richardson iteration for the matrix exponential

Mike Botchev (AACS, UTwente)

Iterative solvers are often constructed with regard to a residual, example: $Ax = b$, $x_0, x_1, \ldots, x_k \to x$, $r_k = b - Ax_k$

For many important matrix functions $f(A)$ no natural notion for residuals exists.

A definition of a residual for the matrix exponential $\exp(A)$ is proposed.

Make existing numerical methods for $\exp(A)$ more reliable.

Construct new methods, which handle the residual.
The BiCOR family of iterative methods for solving nonsymmetric linear systems of equations

Bruno Carpentieri
b.carpentieri@rug.nl

Woudschoten Conferentie 2010
Efficient Simulation of Bessel process

Bin Chen

*CWI*
\[ dX(t) = a(t, X(t)) \, dt + b(t, X(t)) \, \ast \, dW(t) \]
Model of coupled ODEs for transport in cells

Delphine Draelants, Universiteit Antwerpen

- Time-step solution method
- Numerical continuation methods
- Connection stable and unstable solutions

Information about pattern formation and the development of a plant
Pricing hybrid Derivatives

Ir. Lech A. Grzelak
Project leader: Prof. C.W. Oosterlee
Department: Applied Mathematics
Mekelweg 4 2628 CD, Delft
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The Numerical Density-Enthalpy Method for Porous 2-Phase Flow

Stefan Problem

Level Set, Moving Grid, Phase Field methods versus Numerical Density-Enthalpy method

- Same set of equations for all phases
- Physical approach
- Potentially faster, more accurate, and stable

Ibrahim, D.Ibrahim@tudelft.nl
TU Delft, The Netherlands
Accuracy-enhancement of DG solutions for Convection Diffusion Equations
Liangyue Ji, Jennifer K. Ryan and Yan Xu, L.Ji@tudelft.nl

Time-dependent Linear Convection Equation

\[
\begin{aligned}
  u_t + \sum_{i=1}^{d} a_i u_{x_i} + a_0 u - \epsilon \Delta u &= 0, \\
  (x, t) &\in \Omega \times (0, T],
\end{aligned}
\]

We can improve the DG solution from \( O(h^{k+1}) \) to \( O(h^{2k+1}) \).

”How do I get it?” (“see my poster”)

(a) DG solution

(b) Post Processing
On the use of rigid body modes in the deflated preconditioned conjugate gradient method

T. B. Jönsthövel, M. B. van Gijzen, C. Vuik and A. Scarpas
Delft University of Technology, Faculty of Information Technology and Systems, Department of Applied Mathematical Analysis
Applying numerical continuation to the solutions of the Schrödinger equation

Przemysław Kłosiewicz

1. Look at QM systems described by

\[
\left( -\frac{1}{2} \Delta + V(x) \right) \psi(x) = E \psi(x)
\]

2. with solutions such as

3. Use numerical continuation to obtain complex potential energy surfaces automatically

Details / techniques / applications / challenges
Come see my poster!
Model Order Reduction for Complex High-tech Systems

Agnieszka Lutowska
a.lutowska@tue.nl
Shear Stress Predictions for a Model Aneurysm using the Immersed Boundary Method

Julia Mikhal, Bernard J. Geurts

Dept. of Applied Mathematics – University of Twente
Enschede – The Netherlands

WSC 2010: Zeist, October 6-8, 2010
Sound propagation in a lined duct with flow
M. Oppeneer (NLR/TUE), S.W. Rienstra (TUE), P. Sijtsma (NLR), R.M.M. Mattheij (TUE)

- **Context:**
  - Reduce aircraft engine noise

- **Goal: models for sound propagation**
  - Semi-analytic
  - Numerical (for design calculations)

- **Model: hollow tube with**
  - Sound absorbing walls
  - Non-uniform mean flow speed
  - Non-uniform mean temperature
  - Segments

- **Mathematical modeling**
  - Acoustic perturbations of mean flow
  - Modal solutions of Navier-Stokes
  - To be solved: BVP

- **Numerical solution**
  - Goal: find all modes, fast
  - Method: continuation

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**Diagram:**
- Cool air inlet
- Hard wall
- Resistive sheet
- Liner cavity
- Mean flow profile $\bar{u}(r)$
- Gradual change to numerical solution

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**TU/e NLR - Dedicated to innovation in aerospace**
Direct Numerical Simulation of homogeneous straining flows

Dr. P. Perlekar, Dr. C. Lee, and Prof. F. Toschi
An extended Fourier modal method for plane-wave scattering from finite structures

M. Pisarenco, J.M.L. Maubach, I. Setija, R.M.M. Mattheij
Chebyshev lattices: cubature qualities and fast implementation

Koen Poppe, Ronald Cools
Stability analysis for a peri-implant osseointegration model

Process in reality

Mathematical model

Simulations

P. Prokharau           F. Vermolen
Multigrid preconditioned Krylov methods for Helmholtz equations on complex stretched domains

Bram Reps

● What?
  ▶ indefinite Helmholtz equations
  ▶ absorbing boundary conditions
  ▶ quantum mechanics

● How?
  ▶ Krylov subspace methods
  ▶ multigrid preconditioning
  ▶ complex shifted Laplacian
  ▶ complex stretched grid

● So?
  ▶ theoretical numerical analysis
  ▶ convergence results

Universiteit Antwerpen
Optimizing multigrid for higher order accurate space-time discontinuous Galerkin discretizations

S. Rhebergen and J.J.W. van der Vegt

Universiteit Twente.
Efficient Friction Factor Computation for Flow in Corrugated Pipes

Woudschoten 2010
Patricio Rosen
Multi-model coupling for fluid-structure interaction

T.P. Scholcz, A.H. Van Zuijlen, H. Bijl
Delft University of technology, Faculty of Aerospace Engineering

Keywords: Multi-model defect correction, space-mapping, partitioned fluid-structure interaction
On iterative solution of Helmholtz equation

A.H. Sheikh, D, Lahaye & C. Vuik

- Complex shifted Laplace preconditioner
- With Multigrid deflation, h-independent solution
- Sparse deflation matrix
- Local Fourier analysis of schemes (on the way)
The Hidden Accuracy of DG

Paulien van Slingerland
Jennifer Ryan
Kees Vuik

TU Delft
FA8655-09-1-3055
Lattice Boltzmann method for axis-symmetric multiphase flow

Sudhir Srivastava
Dr. Prasad Perlekar
Prof. dr. Federico Toschi

(MTP) Mesoscopic transport phenomenon TU/e
What if your favourite direct solver does not fit in your computer?
What if your favourite iterative solver fails?
Use hybrid direct/iterative solvers!!

A new hybrid direct/iterative solver for large sparse (indefinite) systems

Jonas Thies and Fred Wubs
Johann Bernoulli Institute
University of Groningen, the Netherlands
Lifting in hybrid lattice Boltzmann and PDE models

- Individual-based models: computationally expensive
- Hybrid models

Missing data problem

Constant extrapolation
\[ |\rho_{\text{hybrid}} - \rho_{\text{LBM}}| \]

Linear extrapolation
\[ |\rho_{\text{hybrid}} - \rho_{\text{LBM}}| \]

Modeling error
Context: Linear System Solving For Finite Element Method

Solving the large-scale element-structured sparse linear system

\[ Ax = b, \]

which was derived from a finite element discretization, and where

\[ A = \sum_{e \in E} P_e A_e P_e^T, \]

with \( A_e \) the element matrix and \( P_e \) the standard local-to-global mapping.

Numerical Result: Navier-Stokes Model Problem

- **ILU(0):** The standard no-fill ILU preconditioner.
- **ILUT(\( p, \tau \)):** The dual-threshold preconditioner.

![Graph showing numerical results for different preconditioners for the Navier-Stokes problem.](image)

The graph shows the norm of the residual against execution time for various preconditioners, including ILU(0), ARMS(\( \tau \)), ILUT(\( p, \tau \)), and EBE-ML-ILU(\( k \)). Each line represents a different preconditioner, with the legend indicating the number of non-zero elements (nnz) for each case.

- **ILU(0):** 1,277,413 nnz
- **ARMS(\( \tau \)):** 3,117,731 nnz
- **ILUT(\( p, \tau \)):** 4,552,362 nnz
- **ARMS(\( \tau \)):** 7,638,930 nnz
- **EBE-ML-ILU(\( k \)):** 7,429,179 nnz
- **EBE-ILU(\( k \)):** 27,066,43 nnz

**Competition:** Combine As Many Buzzwords As You Can In One Preconditioner

- **finite element method,**
- **parallelizable,**
- **agglomerate,**
- **BLAS3,**
- **block-ILU,**
- **multifrontal method,**
- **preconditioner,**
- **multilevel,**
- **dense matrices,**
- **high-throughput,**
- **BLAS2,**
- **sparse matrix,**
- **local assembly,**
- **element matrices,**
- **high quality factorization,**
- **discard policy,**
- **element-by-element,**
- **LAPACK.**
Adaptive grid refinement for ship flow simulation

Jeroen Wackers and Michel Visonneau
Laboratoire de Mécanique des Fluides - CNRS UMR 6598
Ecole Centrale de Nantes, FRANCE
Road network traffic flow

- Traffic flow simulation
- Novel simulation method
- Real road networks
- Traffic management

Femke van Wageningen-Kessels
Yufei Yuan
Serge Hoogendoorn
Hans van Lint
Kees Vuik

TUDelft
Modelling Biogrout: 
a new ground improvement method

Miranda van Wijngaarden\textsuperscript{1,2}, Fred Vermolen\textsuperscript{2}, Gerard van Meurs\textsuperscript{1}, Kees Vuik\textsuperscript{2}

\textsuperscript{1} Deltares, Geo Engineering, the Netherlands
\textsuperscript{2} Delft University of Technology, Delft Institute of Applied Mathematics, the Netherlands
Modelling Radar Response of Ferromagnetic Coatings

Elwin van ‘t Wout
Mathematical Model of Bacterial Self-Healing of Cracks in Concrete

S.V. Zemskov\textsuperscript{1}, H.M. Jonkers\textsuperscript{2}, F.J. Vermolen\textsuperscript{1}

\textsuperscript{1} Faculty of Electrical Engineering, Mathematics and Computer Science, \textsuperscript{2} Faculty of Civil Engineering and Geosciences

Key principles of bacterial crack closure in concrete

Calcium lactate ($\text{C}_6\text{H}_{10}\text{CaO}_6$) is converted by bacteria into calcium carbonate ($\text{CaCO}_3$)

Mathematical model of crack closure (2D)

Moving boundary problem: computational domain evolves in time

Numerical methods and algorithms

- Finite Element Method
  - \textit{Cut-Cell Approach}
- Level Set Method
  - \textit{Euler forward method}
  - \textit{Fast Marching Method}
We have implemented Fourier Cosine (COS) pricing method on GPU for European and Bermudan options and have achieved 10-100 times speed up, which is important for calibration and hedging.