Lecturer : Christina C. Christara  
Lectures : Wednesday 1-3pm, Room BA B025  
Tutorial : Monday 2-3pm, Room BA 2195 (tutorials will be used for lectures)  
Office Hours : Monday 3:30-4:30pm, Room BA 4226, other hours by appointment  

Topics to be covered
- **Introduction**
  - Parallel architectures, communication complexity; Speedup, efficiency
  - Simple examples: inner product, matrix-vector multiplication, total exchange
  - Performance study
- **Linear systems - Direct methods**
  - Gauss elimination, LU factorisation, Cholesky decomposition, back substitution
  - Banded systems; Cyclic reduction; Partitioning methods
- **Linear systems - Iterative methods**
  - Jacobi, Gauss Seidel, SOR, SSOR and conjugate gradient methods
  - Preconditioning; Sparse linear systems; Multicolouring
  - Asynchronous iterations
- **Partial Differential Equations**
  - Schur complement - domain decomposition method
  - Schwarz splitting - domain decomposition method
  - Multigrid method
  - Fast Fourier Transform methods
- **Interpolation**
  - Deboor decomposition

Aims of course
- Introduce the basic concepts in parallel computation and state-of-the-art scientific computing.
- Formulate parallel numerical methods.
- Implement the above methods on specific parallel architectures.
- Study the performance of methods and machines.
- Offer lots of fun.

Prerequisites
- Elementary calculus: Taylor series, Rolle’s theorem, mean value theorem, graphs of functions, continuity, convergence, de l’ Hospital’s rule, partial derivatives, etc.
- Numerical Linear Algebra (included in CSC350): rough knowledge of direct and iterative methods for solving linear systems; some familiarity with sparse matrices; fluency in matrix and vector manipulation.
- Interpolation (included in CSC351): some knowledge on interpolation.
- Partial Differential Equations: minimal knowledge on PDEs.
- Theory of Computer Algorithms: some knowledge on data structures, computer algorithms and computational complexity.
- Programming: proficiency in some conventional programming language, preferably C/C++ or FORTRAN; knowledge of MATLAB is an asset.

Tentative marks distribution
- **Assignment 1**
  - Due Wednesday, October 10
  - 20%
- **Term test 1**
  - Wednesday, October 24  
  - 30%
- **Assignment 2**
  - Due Wednesday, November 14
  - 25%
- **Assignment 3**
  - Due Wednesday, December 5
  - 25%
- The final marks distribution will be announced in 3 weeks.
- Term tests (and final exam, if any): Calculators are the only aids permitted.
- The assignments include substantial computer work.
- Assignments are expected to look like short reports, i.e., the presentation of the subject counts too.
References

Christina C. Christara
CSC456-2306 Lecture Notes on the website

James M. Ortega
Introduction to Parallel and Vector Solution of Linear Systems
Plenum Press 1988

Yousef Saad
Iterative Methods for Sparse Linear Systems
PWS 1996 or SIAM 2003
http://www-users.cs.umn.edu/~saad/books.html

Ian Foster
Designing and Building Parallel Programs
Addison Wesley 1995 and
http://www.mcs.anl.gov/dbpp

George Em Karniadakis and Robert M. Kirby II
Parallel Scientific Computing in C++ and MPI
A Seamless Approach to Parallel Algorithms and their Implementation
Cambridge 2003

J. M. Bahi, S. Contassot-Vivier and R. Couturier
Parallel Iterative Algorithms: from sequential to grid computing
Chapman & Hall/CRC 2007

William Gropp, Ewing Lusk and Anthony Skjellum
Using MPI: portable parallel programming with the message-passing interface
MIT Press 2014
see also
http://wgropp.cs.illinois.edu/usingmpiweb/

Michael J. Quinn
Parallel Programming in C with MPI and OpenMP
McGraw Hill 2004

Jianping Zhu
Solving Partial Differential Equations on Parallel Computers
World Scientific 1994

Ananth Grama, Anshul Gupta, George Karypis and Vipin Kumar
Introduction to Parallel Computing: Design and Analysis of Algorithms
Addison Wesley 2003

Jeffrey D. Ullman
Computational Aspects of VLSI
Computer Science Press 1984

Dimitri P. Bertsekas and John N. Tsitsiklis
Parallel and Distributed Computation; Numerical Methods
Prentice Hall 1989
see also
https://dspace.mit.edu/handle/1721.1/3719#files-area

William W. Hager
Applied Numerical Linear Algebra
Prentice Hall 1988

Gene H. Golub and Charles Van Loan
Matrix computations
John Hopkins University Press 1996

Uri Ascher and Chen Greif
A first course in Numerical Methods
SIAM 2011 (e-book on library)

Samuel D. Conte and Carl de Boor
Elementary Numerical Analysis
SIAM 2018 (also McGraw-Hill Inc.)

David Kincaid and Ward Cheney
Numerical Analysis
Brooks/Cole

Michael Heath
Scientific Computing: an introductory survey
McGraw-Hill Inc.

Richard L. Burden and J. Douglas Faires
Numerical Analysis
Brooks/Cole

John C. Strikwerda
Finite Difference schemes and Partial Differential Equations
Wadsworth and Brooks/Cole 1989

William F. Ames
Numerical Methods for Partial Differential Equations
(or Thomas Nelson & Sons)

P. M. Prenter
Splines and Variational Methods
John Wiley & Sons 1975

William L. Briggs, Van Emden Henson, Steve McCormic
A multigrid tutorial
SIAM 2000
Selected papers