Preface

This volume presents a selection of 62 peer-reviewed papers that were submitted to the proceedings of the 27th International Conference on Domain Decomposition Methods held in Prague, Czech Republic, from July 25 to 29, 2022.

Background of the Conference Series

With its first meeting in Paris in 1987, the International Conferences on Domain Decomposition Methods have been held in 16 countries in Asia, Europe, and North America, and now for the first time in the Czech Republic. The conference is held at roughly 18-month intervals. A complete list of the 27 meetings appears below.

Domain decomposition is often seen as a form of the divide-and-conquer approach for mathematical problems posed over a physical domain, reducing a large problem into a collection of smaller problems, each of which is much easier to solve computationally than the undecomposed problem, and most or all of which can be solved independently and concurrently, and then solved iteratively in a consistent way. A lot of the theoretical interest in domain decomposition algorithms lies in ensuring that the number of iterations required to converge is very small. Domain decomposition algorithms can be tailored to the properties of the physical system, as reflected in the mathematical operators, to the number of processors available, and even to specific architectural parameters, such as cache size and the ratio of memory bandwidth to floating point processing rate. Consequently, domain decomposition methods prove to be an ideal paradigm for large-scale simulation on advanced parallel computers and supercomputers.

While the technical content of the conference revolves mainly around mathematics, its underlying motivation lies in enabling efficient utilization of distributed memory computers for complex scientific and engineering applications. Although research on domain decomposition methods is presented at various events, the International Conference on Domain Decomposition Methods stands as the singular recurring international forum dedicated to fostering interdisciplinary interactions

between theoreticians and practitioners. These interactions span the development, analysis, software implementation, and applications of domain decomposition methods.

As we are entering the era of exascale computing, with the most powerful supercomputers now capable of sustaining 10^{18} floating-point operations per second, the need for efficient and mathematically sound methods for solving large-scale systems becomes increasingly vital. Furthermore, these methods must align well with the modern high-performance computing (HPC) architectures. The massive parallelism inherent in exascale computing necessitates the development of new solution methods that effectively leverage the abundance of computing cores and hierarchical memory access patterns. Ongoing advancements, such as parallelization in time, asynchronous iterative methods and nonlinear domain decomposition methods show that this massive parallelism not only calls for novel solution and discretization approaches but also facilitates their further development.

Here is a list of the 27 conferences on Domain Decomposition Methods:

1. Paris, France, January 7–9, 1987
2. Los Angeles, USA, January 14–16, 1988
3. Houston, USA, March 20–22, 1989
4. Moscow, USSR, May 21–25, 1990
5. Norfolk, USA, May 6–8, 1991
6. Como, Italy, June 15–19, 1992
7. University Park, Pennsylvania, USA, October 27–30, 1993
8. Beijing, China, May 16–19, 1995
9. Ullensvang, Norway, June 3–8, 1996
10. Boulder, USA, August 10–14, 1997
11. Greenwich, UK, July 20–24, 1998
12. Chiba, Japan, October 25–20, 1999
13. Lyon, France, October 9–12, 2000
14. Cocoyoc, Mexico, January 6–11, 2002
15. Berlin, Germany, July 21–25, 2003
16. New York, USA, January 12–15, 2005
17. St. Wolfgang–Strobl, Austria, July 3–7, 2006
18. Jerusalem, Israel, January 12–17, 2008
19. Zhangjiajie, China, August 17–22, 2009
20. San Diego, California, USA, February 7–11, 2011
21. Rennes, France, June 25–29, 2012
22. Lugano, Switzerland, September 16–20, 2013
23. Jeju Island, Korea, July 6–10, 2015
24. Spitsbergen, Svalbard, Norway, February 6–10, 2017
25. St. John's, Newfoundland, Canada, July 23–27, 2018
26. Hong Kong SAR (virtual format), China, December 7–12, 2020
27. Prague, Czech Republic, July 25–29, 2022

International Scientific Committee on Domain Decomposition Methods

- Petter Bjørstad, University of Bergen, Norway
- Susanne Brenner, Louisiana State University, USA
- Xiao-Chuan Cai, CU Boulder, USA
- Martin Gander, University of Geneva, Switzerland
- Laurence Halpern, University Paris 13, France
- David Keyes, KAUST, Saudi Arabia
- Hyea Hyun Kim, Kyung Hee University, Korea
- Axel Klawonn, Universität zu Köln, Germany
- Ralf Kornhuber, Freie Universität Berlin, Germany
- Ulrich Langer, University of Linz, Austria
- Luca F. Pavarino, University of Pavia, Italy
- Olof B. Widlund, Courant Institute, USA
- Jinchao Xu, Penn State, USA
- Jun Zou, Chinese University of Hong Kong, Hong Kong

About the 27th Conference

The twenty-seventh International Conference on Domain Decomposition Methods had 200 participants (187 onsite and 13 online) from 25 different countries. The conference featured 11 invited presentations selected by the International Scientific Committee with both experienced and younger speakers, 17 minisymposia on specific topics and 6 contributed paper sessions. The present proceedings contain a selection of 62 papers, grouped into three separate groups: 4 papers by plenary speakers, 48 minisymposium papers, and 10 contributed papers.

Organizers

- VSB – Technical University of Ostrava
- Institute of Mathematics of the Czech Academy of Sciences
- Czech Technical University in Prague

Sponsoring organizations

- Hewlett Packard Enterprise (gold partner)
- Atos
- M Computers
- RSJ Foundation
- Research Center for Informatics

Local Organizing/Program Committee Members

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- Jaroslav Kruis, Czech Technical University in Prague, Czech Republic
- Ulrich Langer, Johannes Kepler University Linz, Austria
- Daniel Langr, Czech Technical University in Prague, Czech Republic
- Jakub Šístek, Institute of Mathematics of the Czech Academy of Sciences, Prague, Czech Republic

Plenary Presentations

- Silvia Bertoluzza (CNR — Istituto di Matematica Applicata e Tecnologie Informatiche "Enrico Magenes")
  Domain decomposition for the Virtual Element Method
- Xiao-Chuan Cai (Department of Mathematics, University of Macau)
  Schwarz for complex fluid and solid problems in biomechanics
- Alexander Heinlein (Delft University of Technology)
  Robust, algebraic, and scalable Schwarz preconditioners with extension-based coarse spaces
- Florence Hubert (Institut de Mathematiques de Marseille, Aix-Marseille Université, France)
  On discrete optimized Schwarz algorithms for elliptic problems
- Hyea Hyun Kim (Kyung Hee University, Korea)
  Domain decomposition algorithms for neural network approximation of partial differential equations
- Maksymilijan Dryja (the winner of the Olof Widlund Prize), a talk presented by Marcus Sarkis (University of Warsaw / Worcester Polytechnic Institute)
  NOSAS and RAS/ASH
- Robert Scheichl (Heidelberg University, Germany)
  Multiscale Generalised Finite Element Methods
- Jonathan W. Siegel (Pennsylvania State University/Texas A&M University)
  Approximation Properties of Neural Networks and Applications to Numerical PDEs
- Jakub Šístek (Institute of Mathematics of the Czech Academy of Sciences)
  Applications of multilevel BDDC to problems of incompressible flows
- Barbara Wohlmuth (Technical University of Munich)
  Multi-physics models with mixed dimensions: Bio-medical and seismic applications
- Stefano Zampini (King Abdullah University of Science and Technology, Saudi Arabia)
  Device Accelerated solvers with PETSc: current status, future perspectives, and applications

Acknowledgments

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Prague, October 2023

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