LECTURE NOTES IN COMPUTATIONAL SCIENCE AND ENGINEERING 145

Susanne C. Brenner · Eric Chung
Axel Klawonn · Felix Kwok · Jinchao Xu
Jun Zou *Editors*

Domain Decomposition Methods in Science and Engineering XXVI

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Preface

This volume contains a selection of 84 papers submitted to the 26th International Conference on Domain Decomposition Methods, hosted by the Department of Mathematics at the Chinese University of Hong Kong, and held virtually on December 7–12, 2020.

Background of the Conference Series

With its first meeting in Paris in 1987, the International Conference on Domain Decomposition Methods has been held in 15 countries in Asia, Europe, and North America, and now for the first time in Hong Kong SAR, China. The conference is held at roughly 18-month intervals. A complete list of the 26 meetings appears below.

Domain decomposition is often seen as a form of divide-and-conquer 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. Much 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, proving it to be an ideal paradigm for large-scale simulation on advanced architecture computers.

The principal technical content of the conference has always been mathematical, but its motivation has primarily been to make efficient use of distributed memory computers for complex applications arising in science and engineering. While research in domain decomposition methods is presented at numerous venues, the International Conference on Domain Decomposition Methods is the only regularly occurring international forum dedicated to interdisciplinary technical interactions

between theoreticians and practitioners working in the development, analysis, software implementation, and application of domain decomposition methods.

As we approach the dawn of exascale computing, where we will command 10^{18} floating point operations per second, efficient and mathematically well-founded methods for the solution of large-scale systems will clearly become more and more important — as will their sound realization in the framework of modern HPC architectures. In fact, the massive parallelism, which makes exascale computing possible, requires the development of new solution methods, which are capable of efficiently exploiting this large number of cores as well as the connected hierarchies for memory access. Ongoing developments such as parallelization in time asynchronous iterative methods or nonlinear domain decomposition methods show that this massive parallelism not only demands new solution and discretization methods, but also fosters the development of new approaches.

Here is a list of the 26 conferences on Domain Decomposition:

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

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About the 26th Conference

The twenty-sixth International Conference on Domain Decomposition Methods had close to 250 participants from about 30 different countries. The conference contained 12 invited presentations selected by the International Scientific Committee, fostering both experienced and younger scientists, 22 minisymposia around specific topics and 6 contributed sessions. The present proceedings contain a selection of 84 papers grouped into three separate groups: 9 plenary papers, 60 minisymposium papers, and 15 contributed papers.

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- The Hong Kong Mathematical Society

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- Jun Zou, The Chinese University of Hong Kong

Plenary Presentations

- *Local Multiscale Model Reduction and Applications*, Eric Chung (The Chinese University of Hong Kong, Hong Kong SAR)
- *Robust Solvers for Time-Harmonic Wave Propagation Problems*, Victorita Dolean (Université Côte d'Azur, France and Strathclyde University, Scotland)
- *Improving Efficiency of Scalable TFETI/BETI Contact Solvers for Huge Problems*, Zdeněk Dostál (Technical University of Ostrava, Czech Republic)
- *An Efficient and High Order Accurate Direct Solution Technique for Variable Coefficient Elliptic Partial Differential Equations*, Adrianna Gillman (University of Colorado, Boulder, USA)
- *Fundamental Coarse Space Components for Schwarz Methods with Cross-points*, Laurence Halpern (Université Paris 13, France)
- *Domain Decomposition Methods for Time Harmonic Wave Propagation Problems*, Patrick Joly (ENSTA ParisTech, France)
- *Multilevel Strategies for Non-Linear Problems and Machine Learning: On Non-Linear Preconditioning, Multilevel Optimization, and Multilevel Training*, Rolf Krause (University of Lugano, Switzerland)
- *Adaptive Space-Time Finite Element and Isogeometric Analysis*, Ulrich Langer (Johannes Kepler University Linz, Austria)
- *From Differential Equations to Deep Learning for Image Processing*, Carola-Bibiane Schönlieb (University of Cambridge, UK)
- *Nonoverlapping Domain Decomposition Methods for Saddle Point Problems*, Xuemin Tu (University of Kansas, USA)
- *Domain Decomposition for Modeling Two-Phase Flow in Porous Media*, Mary Wheeler (University of Texas at Austin, USA)
- *General Convection-Diffusion Problems: Robust Discretizations, Fast Solvers and Applications*, Shuonan Wu (Peking University, China)

Acknowledgments

The organizers would like to thank all the participants for their enthusiasm and carefully prepared contributions that made this meeting a very successful event. A warm thanks also to our sponsors that made the budget come together. We have all experienced a very unique meeting, which was held virtually.

Hong Kong, December 2021.

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