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Substructuring Techniques
and
Domain Decomposition Methods

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SAXE-COBURG
PUBLICATIONS

published 2010 by
Saxe-Coburg Publications
Civil-Comp Ltd, Dun Eaglais, Station Brae
Kippen, Stirlingshire, FK8 3DY, Scotland

Saxe-Coburg Publications is an imprint of Civil-Comp Ltd

Computational Science, Engineering and Technology Series: 24
ISSN 1759-3158
ISBN: 978-1-874672-33-3

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Front cover: Domain Decomposition for 50 subdomains by T. Miyamura. For more information see Chapter 7.

Printed in Great Britain by Bell & Bain Ltd, Glasgow

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Preface

Substructuring and domain decomposition methods are well suited for parallel computations. Indeed, the division of a problem into smaller subproblems, through artificial subdivisions of the domain, is a means for introducing parallelism. Substructuring and domain decomposition strategies include in one way or another the following ingredients: a decomposer to split a mesh into subdomains using different heuristics; local solvers (direct or iterative, exact or approximate) to find solutions for the subdomains for specific boundary conditions on the interface; interface conditions (weak or strong) enforcing compatibility and equilibrium between overlapping or non-overlapping subdomains; and a solution strategy for the interface problem. The differences between the methods lie in how those ingredients are actually put to work and how they are combined to form an efficient solution strategy for the problem at hand.

The golden age of domain decomposition probably came with the emergence of parallel computing: in order to efficiently use the computational power of several processors simultaneously first one has attempted to use additive Schwarz iterations or iterative solvers on the entire domain, using domain decomposition to dispatch the cost of matrix multiplications on the processors. Then Schur complement approaches (primal and dual) were developed: combining efficient solution techniques for the local problems with robust iterative algorithms to solve the interface problem one could build strategies to use the full potential of multiprocessor machines. Those methods were further developed to improve their robustness for practical engineering problems. Even today, despite the many reported successful applications of domain decomposition, making the iterative solution of the interface problem robust and efficiently parallel remains a challenge.

This edited book continues the series on Domain Decomposition Methods for engineering problems and follows the two previous volumes respectively entitled:

- *Mesh Partitioning Techniques and Domain Decomposition Methods (2007)*, edited by F. Magoulès, published by Saxe-Coburg Publications, Stirling, United Kingdom; and
- *Domain Decomposition Methods: Theory and Applications (2006)*, edited by F. Magoulès and T. Kako, published by Gakkotosho, Tokyo, Japan.

The present volume presents in nine chapters a selection of some domain decomposition and substructuring methods including: parareal in time algorithm, transformation methods and induced parallel properties for the temporal domain, asynchronous iterative methods, asynchronous sub-structuring methods, asynchronous multi-splitting methods, parallel iterative methods, coarse grid conjugate gradient, multi-point constraints in domain decomposition methods, approximate inverse preconditioning techniques, congruent sub-domains, linear and non-linear problems. The topics covered in this book are wide ranging and demonstrate the extensive use of substructuring and domain decomposition methods in fluid mechanics, structural mechanics, and computational finance.

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