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Distributed computing through combinatorial topology.

Amsterdam: Elsevier/Morgan Kaufmann (ISBN 978-0-12-404578-1/pbk; 978-0-12-404728-0/ebook). xiv, 319 p. (2014).

The book is the first systematic exposition of an approach to distributed computing based on tools of combinatorial topology. This powerful technique emerged around 1990 in the work of several groups of researchers simultaneously.

A distributed system is a collection of computing entities (processors) that cooperate to solve a common task. The processors communicate my message passing but the communication is typically imperfect due to delays and failures. The theory of distributed computing is largely about the tasks which can or can not be accomplished in the presence of timing uncertainty and failures. The topological approach reduces the problem of computability of various tasks by a distributed system to the questions about the existence of simplicial maps with certain geometric properties between simplicial complexes canonically associated to the system.

The book is divided into four parts. Part I (entitled "Fundamentals") consists of three chapters giving the first layer of description of problems of distributed computing and their topological interpretation. Here the authors treat in full detail the case of systems with two-processes motivating the topological approach developed further in the book. The authors consider many important practical examples, for instance the approximate agreement task. Part I also contains a chapter with an exposition of basic notions of combinatorial topology.

Part II of the book (Chapters 4–7) studies "colorless tasks", a special class of computational tasks in which one cares only about the sets of inputs and outputs regardless of which processes are associated with these values; this class includes many important practical examples. Chapter 4 studies colorless wait-free computation and the main result (Theorem 4.3.1) gives necessary and sufficient conditions for solvability in terms of the existence of certain continuous maps between high-dimensional simplicial complexes. As an application, the authors treat the Set Agreement problem using the well-known Sperner's Lemma and establish the non-existence of wait-free colorless protocols for n-set agreement between $n+1$ processes. In the following chapters different colorless tasks having various communication mechanisms and various fault-tolerant requirements are treated.

Part III deals with general computational tasks and the assumption of "colorlessness" is dropped. The authors describe a wide class of tasks and show how the topological language and topological reduction developed in the previous chapters can be generalised. One of the chapters studies *manifold tasks*, having interesting geometric features. In the final chapter of this part the authors give necessary and sufficient conditions for solvability of general tasks for many models of computation.

Part IV (Chapters 12–16) describes some advanced topics of distributed computing which also use notions of topology.

The book is well illustrated, it contains many figures and examples, and each chapter includes multiple exercises and historical notes.

The book is a valuable addition to the existing literature, it will be appreciated by many different categories of readers including university students and researchers in computers science as well as topologists interested in practical applications. *Michael Farber (London)*