







# Handbook of Automata Theory

Volume I  
Theoretical Foundations

Edited by Jean-Éric Pin



**Editor:**

Jean-Éric Pin  
Institut de Recherche en Informatique Fondamentale (IRIF)  
Université de Paris and CNRS  
Bâtiment Sophie Germain, Case courrier 7014  
8 Place Aurélie Nemours  
75205 Paris Cedex 13  
E-mail: Jean-Eric.Pin@irif.fr

**Volume I:**

**2020 Mathematics Subject Classification:** 68Q45; 03B50, 03D05, 08A70, 08B20, 15A80, 16Y60, 20E18, 20M05, 20M07, 20M35, 28A05, 68Q32, 68Q42, 68Q70, 68R10, 68T05

**Keywords:** finite automata, Hopcroft's algorithm, regular languages, regular expressions, finite transducers, weighted automata, automata on infinite words, automata on trees, picture languages, algorithmic learning, descriptive complexity, Boolean circuits, synchronizing automata, road colouring problem, varieties of languages, profinite topology, descriptive set theory, equational theories, language equations, forest algebras

ISBN Vol. I    978-3-98547-002-0  
ISBN Vol. II    978-3-98547-003-7  
ISBN Set        978-3-98547-006-8 (set of both volumes)

**Bibliographic information published by the Deutsche Nationalbibliothek**

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at <http://dnb.dnb.de>.

Published by EMS Press, an imprint of the

European Mathematical Society – EMS – Publishing House GmbH  
Institut für Mathematik  
Technische Universität Berlin  
Straße des 17. Juni 136  
10623 Berlin, Germany

<https://ems.press>

© 2021 EMS Press

Cover drawing of Jacques de Vaucanson's digesting duck (*canard digérant*) published in *Scientific American* Vol. 80 (3), 1899. Fractal tree on the first page by Nicolas Janey.

Typeset using the authors' LaTeX sources: Marco Zunino, Savona, Italy  
Printing and binding: Beltz Bad Langensalza GmbH, Bad Langensalza, Germany  
⊗ Printed on acid free paper  
9 8 7 6 5 4 3 2 1