

Review of
Algorithms and Theory of Computation Handbook ¹
Edited by : Mikhail J. Atallah and Marina Blanton
Publisher: Chapman & Hall / CRC Press, 2010
ISBN: 978-1-58488-822-2, Price: \$157.63
Two Volumes: *General Concepts and Techniques (Vol. I)*
and *Special Topics and Techniques (Vol. II)*

Reviewer: Nick Papanikolaou (N.Papanikolaou@warwick.ac.uk)

1 Overview

This pair of volumes is an extensive compendium of survey articles on issues of current importance in theoretical CS research. Without a shadow of a doubt it is a much needed resource for any theory researcher, as well as serving as a detailed introduction to the field for non-specialists. The first volume covers algorithms and algorithmic techniques, aspects of data structures, complexity theory, formal languages and computability, in addition to having a handful of chapters on related but more specialised topics, such as learning theory, coding theory, parallel and distributed computing. This volume in itself is a treasure of material in core computer science and can serve as a replacement for more specialised texts when only a good foundation is required. The articles are written by experts in the field and are eminently readable.

There is a couple of very useful chapters on searching and sorting algorithms, which can be used as a complement and gentle introduction to Knuth's seminal tome [1] on the subject. But to have, in the very same volume, an equally accessible introduction to convex optimization, and another on simulated annealing, makes for a rich and enjoyable afternoon read. In fact, you may find yourself wondering many times whether you could change research topic or theme, as this volume is rather inspiring!

While there is still emphasis on algorithms and algorithmic approaches, Volume II has a broader remit and introduces several application areas, including AI and robotics, cryptography, voting and auction schemes, privacy and databases, computational biology, grid and DNA computing. What a feast! The coverage of cryptography, cryptanalysis and security protocols is particularly extensive, which makes this a useful reference for security research. The chapter on privacy and anonymity is particularly relevant and a very timely review of k -anonymity techniques. In the wake of Narayanan and Shmatikov's recent award-winning results on the de-anonymisation of the Netflix prize database [2], this material is particularly interesting and should serve as a foundation for further research on anonymity and anonymisation methods.

It is not possible to review this pair of volumes in the usual manner, due to their length and the sheer breadth of material. I will provide the table of contents for both volumes in Section 2, however, for readers of this review to get an inkling of the variety therein. Then I will give and justify my opinion of this text, concluding with references.

¹© Nick Papanikolaou, 2010

Comparison with *Handbook of Theoretical Computer Science*

It is interesting to make a comparison with the already established *Handbook of Theoretical Computer Science* [3, 4], edited by Leeuwen. Leeuwen's book is also extensive, and is similarly divided into one volume on Algorithms and Complexity [3] and another on Formal Models and Semantics [4].

First one should point out that Leeuwen's book is older, and is not designed to be as broad an introduction as this one is. So the contributions in the former tend to be not just survey articles, but often also focused research articles which also give general background on the topics of interest. There is some degree of overlap, especially with regard to complexity theory, but Leeuwen's volumes do not introduce algorithmics in a textbook manner. Some of the chapters have very similar coverage to those in this handbook (under review), although this handbook is more up-to-date. VLSI theory is covered in both, data structures, cryptography and graph algorithms also.

The fundamental difference between the *Handbook of Theoretical Computer Science* by Leeuwen and the handbook under review is one of style. While the former has detailed chapters on a selection of topics, the latter has more extensive and systematic coverage of algorithms arising across the spectrum of computer science research.

The next section shows the contents of the two volumes. In Section 3 I round off this review with a personal view.

2 Tables of Contents

2.1 Volume I: General Concepts and Techniques

Preface	ix	Camil Demetrescu, David Eppstein, Zvi Galil, and Giuseppe F. Italiano 9-1
Editors	xi	10 External-Memory Algorithms and Data Structures
Contributors	xiii	Lars Arge and Norbert Zeh10-1
1 Algorithm Design and Analysis Techniques		11 Average Case Analysis of Algorithms
Edward M. Reingold	1-1	Wojciech Szpankowski11-1
2 Searching		12 Randomized Algorithms
Ricardo Baeza-Yates and Patricio V. Poblete ...	2-1	Rajeev Motwani and Prabhakar Raghavan12-1
3 Sorting and Order Statistics		13 Pattern Matching in Strings
Vladimir Estivill-Castro	3-1	Maxime Crochemore and Christophe Hancart . 13-1
4 Basic Data Structures		14 Text Data Compression Algorithms
Roberto Tamassia and Bryan Cantrill	4-1	Maxime Crochemore and Thierry Lecroq 14-1
5 Topics in Data Structures		15 General Pattern Matching
Giuseppe F. Italiano and Rajeev Raman	5-1	Alberto Apostolico
6 Multidimensional Data Structures for Spatial Applications	15-1
Hanan Samet	6-1	16 Computational Number Theory
7 Basic Graph Algorithms		Samuel S. Wagstaff, Jr
Samir Khuller and Balaji Raghavachari	7-116-1
8 Advanced Combinatorial Algorithms		17 Algebraic and Numerical Algorithms
Samir Khuller and Balaji Raghavachari	8-1	Ioannis Z. Emiris, Victor Y. Pan, and Elias P. Tsigaridas
9 Dynamic Graph Algorithms	17-1
		18 Applications of FFT and Structured Matrices
		Ioannis Z. Emiris and Victor Y. Pan
	 18-1
		19 Basic Notions in Computational Complex-

ity	Sally A. Goldman 26-1
Tao Jiang, Ming Li, and Bala Ravikumar 19-1	27 Algorithmic Coding Theory
20 Formal Grammars and Languages	Atri Rudra 27-1
Tao Jiang, Ming Li, Bala Ravikumar, and Kenneth W. Regan 20-1	28 Parallel Computation: Models and Complexity Issues
21 Computability	Raymond Greenlaw and H. James Hoover 28-1
Tao Jiang, Ming Li, Bala Ravikumar, and Kenneth W. Regan 21-1	29 Distributed Computing: A Glimmer of a Theory
22 Complexity Classes	Eli Gafni 29-1
Eric Allender, Michael C. Loui, and Kenneth W. Regan 22-1	30 Linear Programming
23 Reducibility and Completeness	Vijay Chandru and M.R. Rao 30-1
Eric Allender, Michael C. Loui, and Kenneth W. Regan 23-1	31 Integer Programming
24 Other Complexity Classes and Measures	Vijay Chandru and M.R. Rao 31-1
Eric Allender, Michael C. Loui, and Kenneth W. Regan 24-1	32 Convex Optimization
25 Parameterized Algorithms	Florian Jarre and Stephen A. Vavasis 32-1
Rodney G. Downey and Catherine McCartin .. 25-1	33 Simulated Annealing Techniques
26 Computational Learning Theory	Albert Y. Zomaya and Rick Kazman 33-1
	34 Approximation Algorithms for NP-Hard Optimization Problems
	Philip N. Klein and Neal E. Young 34-1

2.2 Volume II: Special Topics and Techniques

Preface ix	10 Encryption Schemes
Editors xi	Yvo Desmedt 10-1
Contributors xiii	11 Cryptanalysis
1 Computational Geometry I	Samuel S. Wagstaff, Jr 11-1
D.T. Lee 1-1	12 Crypto Topics and Applications I
2 Computational Geometry II	Jennifer Seberry, Chris Charnes, Josef Pieprzyk, and Rei Safavi-Naini 12-1
D.T. Lee 2-1	13 Crypto Topics and Applications II
3 Computational Topology	Jennifer Seberry, Chris Charnes, Josef Pieprzyk, and Rei Safavi-Naini 13-1
Afra Zomorodian 3-1	14 Secure Multiparty Computation
4 Robot Algorithms	Keith B. Frikken 14-1
Konstantinos Tsianos, Dan Halperin, Lydia Kavradi, and Jean-Claude Latombe 4-1	15 Voting Schemes
5 Vision and Image Processing Algorithms	Berry Schoenmakers 15-1
Concettina Guerra 5-1	16 Auction Protocols
6 Graph Drawing Algorithms	Vincent Conitzer 16-1
Peter Eades, Carsten Gutwenger, Seok-Hee Hong, and Petra Mutzel 6-1	17 Pseudorandom Sequences and Stream Ciphers
7 Algorithmics in Intensity-Modulated Radiation Therapy	Andrew Klapper 17-1
Danny Z. Chen and Chao Wang 7-1	18 Theory of Privacy and Anonymity
8 VLSI Layout Algorithms	Valentina Ciriani, Sabrina De Capitani di Vimercati, Sara Foresti, and Pierangela Samarati 18-1
Andrea S. LaPaugh 8-1	19 Database Theory: Query Languages
9 Cryptographic Foundations	Nicole Schweikardt, Thomas Schwentick, and Luc Segoufin 19-1
Yvo Desmedt 9-1	20 Scheduling Algorithms
	David Karger, Cliff Stein, and Joel Wein 20-1
	21 Computational Game Theory: An Intro-

duction	Gopal Pandurangan and Maleq Khan 27-1
Paul G. Spirakis and Panagiota N. Panagopoulou 21-1	28 Network Algorithmics
22 Artificial Intelligence Search Algorithms	George Varghese 28-1
Richard E. Korf 22-1	29 Algorithmic Issues in Grid Computing
23 Algorithmic Aspects of Natural Language Processing	Yves Robert and Frdric Vivien 29-1
Mark-Jan Nederhof and Giorgio Satta 23-1	30 Uncheatable Grid Computing
24 Algorithmic Techniques for Regular Networks of Processors	Wenliang Du, Mummoorthy Murugesan, and Jing Jia 30-1
Russ Miller and Quentin F. Stout 24-1	31 DNA Computing: A Research Snapshot
25 Parallel Algorithms	Lila Kari and Kalpana Mahalingam 31-1
Guy E. Blelloch and Bruce M. Maggs 25-1	32 Computational Systems Biology
26 Self-Stabilizing Algorithms	T.M. Murali and Srinivas Aluru 32-1
Sbastien Tixeuil 26-1	33 Pricing Algorithms for Financial Derivatives
27 Theory of Communication Networks	Ruppa K. Thulasiram and Parimala Thulasiraman 33-1

3 Opinion

I think this handbook is an essential resource for any computer science researcher, whether theorist or practitioner. It comes at a price, but the introductory coverage of such a wide range of topics is likely to be useful throughout one’s career in computer science. For the moment, it is also a practical way of getting into some of the ”hot” areas of the field, and I found the chapters on DNA computing and computational systems biology very welcoming.

One omission from this handbook which I believe could be addressed in a future edition would be a chapter on quantum algorithms. The rapid growth of this field cannot be ignored, and its impact on computing cannot be underestimated as we get closer and closer to transcribing bits on the atomic scale. The efficiency of quantum algorithms, namely the massive parallelism which is... unparalleled by their classical counterparts, makes for an exciting and attractive research proposition. Inclusion of a chapter on this material in a handbook such as this one would make the field more accessible to a wider audience.

All in all, I highly recommend this pair of volumes for inclusion in your bookshelf.

References

- [1] Donald E. Knuth. *The Art of Computer Programming*, volume 3: Sorting and Searching. Addison-Wesley Professional, 2nd edition, 1998.
- [2] Arvind Narayanan and Vitaly Shmatikov. Robust de-anonymization of large sparse datasets. In *Proceedings of 29th IEEE Symposium on Security and Privacy, Oakland, CA*, pages 111–125, May 2008.
- [3] Jan van Leeuwen, editor. *Handbook of Theoretical Computer Science*, volume A: Algorithms and Complexity. MIT Press, 1994.
- [4] Jan van Leeuwen, editor. *Handbook of Theoretical Computer Science*, volume B: Formal Models and Semantics. MIT Press, 1994.