UNIVERSITY OF OXFORD
DEPARTMENT OF COMPUTER SCIENCE

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Charles University in Prague

15th July 2020

Report on the habilitation thesis submitted by Dr. Martin Mareš

I start with an overview and then give an assessment of the presented textbook entitled "*Průvodce labyrintem algoritmů*", co-authored by Martin Mareš and Tomáš Valla.

Overview:

Chapter 1 starts off with a few classic algorithmic jewels, including a linear-time algorithm for a subsequence with the largest sum, binary search, Euclid's algorithm, and fast exponentiation.

Chapter 2 introduces the basics of time and space complexity, asymptotic notation, and discusses computational models.

Chapter 3 focuses on sorting. The chapter presents basic quadratic algorithms, an n*log n lower bound for comparison-based algorithms, and finally merge sort, bucketsort, and radixsort.

Chapter 4 presents basic data structures, including queues, sets, binary heaps (and heapsort), tries, prefix sums, and interval trees.

Chapter 5 includes basic graph algorithms: graph representation, breadth-first search depth-first search with applications (articulation points and bridges, linear-time algorithms for strongly connected components), and topological ordering.

Chapter 6 focuses on shortest paths in graphs and presents Dijkstra's algorithm, the Bellman-Ford algorithm, and the Floyd-Warshall algorithm.

Chapter 7 discusses minimum spanning trees and presents Prim's algorithm, Borůvka's algorithm, Kruskal's algorithm, and the union find data structure with path compressions.

Chapter 8 is dedicated to binary search trees, AVL trees, (a,b)-trees, and red-black trees.

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Chapter 9 introduces amortised complexity. In particular, it discusses dynamic arrays, binary counters, the potential method for amortised analysis, balanced trees, and splay trees.

Chapter 10 is devoted to the divide and conquer paradigm. It presents the Hanoi tower puzzle, mergesort, Karatsuba's fast number multiplication algorithm, a Master theorem for analysing divide and conquer algorithms, Strassen's fast matrix multiplication algorithm, quickselect, quicksort, and a linear-time algorithm for finding the k-th smallest element.

Chapter 11, after presenting the basics of probability, gives an analysis of expected running time of quicksort. It also presents and analyses hashing and universal hashing.

Chapter 12 is about dynamic programming. Examples of discussed problems include Fibonacci numbers, longest increasing subsequence, edit distance, and optimal search trees,

Chapter 13 presents basic pattern matching algorithms, include the Knuth-Morris-Pratt algorithm, Aho-Corasik algorithm, and the Rabin-Karp algorithm.

Chapter 14 discusses flows in graphs. It presents both basic topics, such as the Ford-Fulkerson algorithm, maximum matching in bipartite graphs, and Dinic's algorithm, but also Goldberg's preflow-push algorithm.

Chapter 15 is about parallel algorithms. The topics covers include definitions and basic properties of circuits, algorithms for parallel addition and multiplication of two binary numbers, and sorting networks (including bitonic sort).

Chapter 16 presents basic geometric algorithms. In particular, the reader learns how to construct a convex hull, solve the line segment intersection problem, construct Voronoi diagrams, and finally solve the planar point location problem using persistent search trees.

Chapter 17 is dedicated to discrete Fourier transform (FFT). It shows how to compute it efficiently and how to use it.

Chapter 18 is about advanced heaps and focuses on binomial heaps and Fibonacci heaps.

The final Chapter 19 is a gentle introduction to NP-hardness with a few basic reductions and approximation algorithms as a method for dealing with hardness.

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Assessment:

Without any doubt, this is an excellent book. On almost 500 pages, this modern textbook covers basic as well as more advanced topics in algorithms. Everything is nicely explained and organised, with lots of useful remarks. Algorithms are presented in a pseudo-code, making the textbook independent of any concrete programming language. Each chapter includes exercises. Moreover, hints are presented to selected exercises.

The presented topics almost cover the syllabus of Oxford's two compulsory courses on algorithms for students reading computer science and joint schools: the first-year course "Design and Analysis of Algorithms" and the second-year course "Algorithms and Data Structures". (The missing topics are greedy algorithms, linear programming, fixed-parameter tractability, and exponential algorithms. On the other hand, some material from Chapters 4, 7, 8, 11, 13, 15 and 16 are not on the syllabus of the two courses.)

Were the textbook written in English, I would happily recommend it to my students as the default textbook for the two courses. I can certainly imagine using this textbook as my main source, having the advantage of knowing Czech. I find it better than the de facto default textbook "Introduction to Algorithms" by Cormen, Leiserson, Rivest, and Stein (MIT Press). I think it's not worse (and find it personally better) than "Algorithm Design" by Kleinberg and Tardos (Addison Wesley), which is to a large extent incomparable topic-wise.

I'd like to note that I don't see any problem with the textbook being co-authored. In fact, submitted documents confirm that Dr. Mareš did a large majority of the work (16 out of the 19 chapters). The textbook is original, as confirmed by a Turnitin originality check, which shows that everything is in good order.

Despite the excellent quality of the textbook, I must admit that I have strong reservations about it as a habiliation thesis. While the textbook is clearly novel and original in the context of Czech textbooks on algorithms, I do not believe that it warranties the title of a docent. In particular, the Charles University rules for the habilitation process in general[1] and in the field of this application (didactics and history of mathematics and computer science) in particular[2] provide guidance on the number and quality of research publications required. As far as I can tell (from the submitted documents, candidate's website and using standard tools such as Google, Google Scholar, DBLP, etc.), the candidate does not fulfil the requirements as he does not have the required publication record (neither in the field of theoretical computer science nor in the field of didactics and history of mathematics and informatics).

[1] https://cuni.cz/UK-9992.html
[2] https://www.mff.cuni.cz/cs/vnitrni-zalezitosti/predpisy/prikazy-a-smernice-dekana/smernice-dekana-c-2-2020

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For the reasons above, I am sorry to say that I **do not** recommend the acceptance of the presented habilitation thesis and the promotion of Martin Mareš to the position of a docent.

Yours faithfully,

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