

Preface

A Euclidean shortest path connects a source with a destination, avoids some places (called *obstacles*), visits some places (called *attractions*), possibly in a defined order, and is of minimum length. Euclidean shortest-path problems are defined in the Euclidean plane or in Euclidean 3-dimensional space. The calculation of a convex hull in the plane is an example for finding a shortest path (around the given set of planar obstacles). Polyhedral obstacles and polyhedral attractions, a start and an endpoint define a general Euclidean shortest-path problem in 3-dimensional space.

The book presents selected algorithms (i.e., not aiming at a general overview) for the exact or approximate solution of shortest-path problems. Subjects in the first chapters of the book also include fundamental algorithms. Graph theory offers shortest-path algorithms for discrete problems. Convex hulls (and to a lesser extent also constrained convex hulls) have been discussed in computational geometry. Seidel's triangulation and Chazelle's triangulation method for a simple polygon, and Mitchell's solution of the continuous Dijkstra problem have also been selected for a detailed presentation, just to name three examples of important work in the area.

The book also covers a class of algorithms (called *rubberband algorithms*), which originated from a proposal for calculating minimum-length polygonal curves in cube-curves; Thomas Bülow was a co-author of the initiating publication, and he coined the name 'rubberband algorithm' in 2000 for the first time for this approach.

Subsequent work between 2000 and now shows that the basic ideas of this algorithm generalised for solving a range of problems. In a sequence of publications between 2003 and 2010, we, the authors of this book, describe a class of rubberband algorithms with proofs of their correctness and time-efficiency. Those algorithms can be used to solve different Euclidean shortest-path (ESP) problems, such as calculating the ESP inside of a simple cube-arc (the initial problem), inside of a simple polygon, on the surface of a convex polytope, or inside of a simple polyhedron, but also ESP problems such as touring a finite sequence of polygons, cutting parts, or the safari, zookeeper, or watchman route problems.

We aimed at writing a book that might be useful for a second or third-year algorithms course at the university level. It should also contain sufficient details for students and researchers in the field who are keen to understand the correctness

proofs, the analysis of time complexities and related topics, and not just the algorithms and their pseudocodes. The book discusses selected subjects and algorithms at some depth, including mathematical proofs for most of the given statements. (This is different from books which aim at a representative coverage of areas in algorithm design.)

Each chapter closes with theoretical or programming exercises, giving students various opportunities to learn the subject by solving problems or doing their own experiments. Tasks are (intentionally) only sketched in the given programming exercises, not described exactly in all their details (say, as it is typically when a costumer specifies a problem to an IT consultant), and identical solutions to such vaguely described projects do not exist, leaving space for the creativity of the student.

The audience for the book could be students in computer science, IT, mathematics, or engineering at a university, or academics being involved in research or teaching of efficient algorithms. The book could also be useful for programmers, mathematicians, or engineers which have to deal with shortest-path problems in practical applications, such as in robotics (e.g., when programming an industrial robot), in routing (i.e., when selecting a path in a network), in gene technology (e.g., when studying structures of genes), or in game programming (e.g., when optimising paths for moves of players)—just to cite four of such application areas.

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