Cambridge University Press
978-0-521-40446-4 - Intersection and Decomposition Algorithms for Planar Arrangements
Pankaj K. Agarwal
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This book presents a study of various problems related to arrangements of lines, segments, or curves in the plane. It starts with a discussion of Davenport-Schinzel sequences, which have been applied to obtain optimal or almost-optimal bounds for numerous combinatorial as well as algorithmic problems involving arrangements. The main result here establishes almost tight bounds on the maximal length of (n,s)–Davenport-Schinzel sequences.

The second problem studied is: given a collection of "red" Jordan arcs and another of "blue" arcs, determine whether any red arc intersects any blue arc. Some fast deterministic algorithms are presented, along with applications to many other problems, including collision detection.

Next, a partitioning algorithm is presented that improves the time complexity of a variety of problems involving lines or segments in the plane. Several applications are discussed, most importantly a fast deterministic algorithm to construct a family of spanning trees with low stabbing number. This is shown to be a versatile tool that provides efficient algorithms for a variety of query-type problems, including ray shooting in an arrangement of segments, polygon containment and implicit hidden surface removal.

Researchers in computational and combinatorial geometry should find much to interest them in this book.

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PREFACE

Computational geometry emerged as a scientific discipline about fifteen years back. It has developed very rapidly during the last few years because of its applications in areas such as robotics, computer graphics, VLSI, CAD, solid modeling, etc. Although it primarily concerns designing efficient algorithms for geometric problems, the algorithmic and combinatorial questions are so interwined in many problems that it is almost impossible to separate one from another. One such area in computational geometry is *arrangements* of lines or curves in the plane, or of hyperplanes and surfaces in higher dimensions. Recently arrangements have received a considerable amount of attention because several fundamental geometric problems can be formulated in terms of arrangements.

This book, based on the author's PhD thesis, studies several algorithmic as well as combinatorial problems involving arrangements of arcs in the plane. The first problem studied here concerns obtaining sharp bounds on the maximum length of *Davenport-Schinzel sequences.* These sequences have been applied to numerous combinatorial as well as algorithmic problems involving arrangements of arcs.

In Chapter 3 we study the *red-blue intersection* problem and its applications to other problems, including collision detection.

Chapter 4 and 5 discuss the following decomposition problem: Given a set of n lines in the plane and a parameter $r \leq n$, decompose the plane into $O(r^2)$ triangles, each of which intersects at most n/r original lines. Chapter 4 presents an efficient algorithm for computing such a partitioning. The application of this algorithm to various other problems is the topic of Chapter 5. The significance of this partitioning algorithm is evident from the problems discussed in Chapter 5.

Finally, in Chapter 6 we show that a spanning tree of a set of points in the plane with the property that each line intersects only few edges of the tree is a versatile tool and that it provides fast procedures for a variety of query-type problems including ray shooting and implicit hidden surface removal.

The open problems mentioned at the end of each chapter suggest further research problems in these areas.

I would like to express my deep sense of gratitude to my thesis advisor

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