Contents

Pı	reface	9	\mathbf{x}^{i}
	Wha	at This Book Contains	X
	Wha	at You Should Know before Reading This Book	X
	How	to Obtain and Install CGAL	xi
	Lice	nse	v.
	Style	e Conventions	v
	Exer	rcises	vi
	Cove	er	vi
	Erra	ıta	vi
	Ackı	$oxed{ ext{nowledgments}}$	vi
1	Tntn	roduction	1
1	1.1	Arrangements	1
	1.1	Generic Programming	2
	1.2	1.2.1 Concepts and Models	2
		1.2.2 Traits Classes	3
		1.2.3 Generic and Object-Oriented Programming	5
		1.2.4 Libraries	7
	1.3	Geometric Computing	7
	1.5	1.3.1 Separation of Topology and Geometry	8
		1.3.2 Exact Geometric Computation	8
		1.3.3 Well-Behaved Curves	9
	1.4		3 10
	1.4		10
			10
			11
			$\frac{11}{12}$
		·	14
			15
	1.5	-	15
	1.6		$\frac{1}{17}$
	1.0	ruither Reading	11
2			19
	2.1	1	19
	2.2		20
			22
			2€
			33
	2.3		36
	2.4		4(
	2.5	Exercises	41

digitalisiert durch DEUTSCHE NATIONAL BIBLIOTHEK viii Contents

3	Que	eries and Free Functions	43
	3.1	Issuing Queries on an Arrangement	43
		3.1.1 Point-Location Queries	43
		3.1.2 Vertical Ray Shooting	47
	3.2	Two Algorithmic Frameworks: Plane Sweep and Zone Construction	48
	3.3	Batched Point-Location	50
	3.4	Free Insertion Functions	51
	0.1	3.4.1 Incremental Insertion Functions	52
		3.4.2 Aggregate Insertion Functions	55
	3.5	Removing Vertices and Edges	57
	3.6	Vertical Decomposition	58
	3.0	· · · · · · · · · · · · · · · · · · ·	59
	9.7	3.6.1 Application : Decomposing an Arrangement of Line Segments	63
	3.7	3 1	
	3.8	Exercises	64
4	Arı	rangements of Unbounded Curves	67
	4.1	Representing Arrangements of Unbounded Curves	67
		4.1.1 Basic Manipulation and Traversal Methods	69
		4.1.2 Free Functions	72
	4.2	Point-Line Duality	73
	7.2	4.2.1 Application: Minimum-Area Triangle	74
		4.2.2 A Note on the Input Precision	79
	4.9	Bibliographic Notes and Remarks	81
	$\frac{4.3}{4.4}$	Exercises	81
	4.4	Exercises	01
5	Arı	rangement-Traits Classes	83
	5.1	The Hierarchy of Traits-Class Concepts	83
		5.1.1 The Basic Concept	84
		5.1.2 Supporting Intersections	85
		5.1.3 Supporting Arbitrary Curves	87
		5.1.4 The Landmark Concept	88
		5.1.5 Supporting Unbounded Curves	89
		5.1.6 The Traits Adaptor	91
	5.2	Traits Classes for Line Segments and Linear Objects	91
	0.2	5.2.1 The Caching Segment-Traits Class	91
			92
	r 0		94
	5.3		94
	5.4	Traits Classes for Algebraic Curves	
		5.4.1 A Traits Class for Circular Arcs and Line Segments	98
		5.4.2 A Traits Class for Conic Arcs	102
		5.4.3 A Traits Class for Arcs of Rational Functions	105
		5.4.4 A Traits Class for Planar Bézier Curves	109
		5.4.5 A Traits Class for Planar Algebraic Curves of Arbitrary Degree	111
	5.5	Traits-Class Decorators	117
	5.6	Application: Polygon Orientation	121
	5.7	Bibliographic Notes and Remarks	124
	5.8	Exercises	126
c	т.	L 3! 41 A	100
6		tending the Arrangement The Notification Mechanism	129
	6.1		129
	6.2	Extending the DCEL	132
		6.2.1 Extending the DCEL Faces	
		6.2.2 Extending All the DCEL Records	-134

Contents

		6.2.3 Input/Output for Arrangements with Auxiliary Data	137
	6.3	Overlaying Arrangements	138
	6.4	Storing the Curve History	146
		6.4.1 Traversing an Arrangement with History	147
		6.4.2 Modifying an Arrangement with History	
		6.4.3 Input/Output for Arrangements with Curve History	
	6.5	Application: Polygon Repairing and Winding Numbers	
	6.6	Bibliographic Notes and Remarks	
	6.7	Exercises	158
7	Ada	apting to BOOST Graphs	161
	7.1	The Primal Arrangement Representation	
	7.2	The Dual Arrangement Representation	
	7.3	Application: Largest Common Point Sets under ϵ -Congruence	
	7.4	Bibliographic Notes and Remarks	
	7.5	Exercises	
_	_		. .
8	Ope 8.1	, ,	1 75 177
	0.1	8.1.1 Polygons with Holes	
		8.1.2 Operations on Polygons with Holes	
			183
		8.1.4 Connecting Holes	
		_	184
		1 0	185
			187
		8.1.8 Performing Multiway Operations	
	8.2	Operations on Curved Polygons	
	0.2	8.2.1 The Traits-Class Concepts	
		8.2.2 Operations on Polygons with Circular Arcs	
		8.2.3 General-Polygon Set Traits-Adaptor	
	8.3	Application: Multiway Operations on General Polygons	
	8.4	Application: Obtaining Silhouettes of Polyhedra	
	8.5	Bibliographic Notes and Remarks	
	8.6	Exercises	
_		1 1 1 G 1 G 1 D 1	000
9			209
	9.1	Computing the Minkowski Sum of Two Polygons	
		9.1.1 Computing Minkowski Sum Using Convolutions	
	0.0		213
	9.2	9	214
		over erren i og og og er	$\frac{215}{217}$
	0.0		217
	9.3	2.20 trans = 2.00 T F == 0.00 T F	219
		9.3.1 Application: A Translating Polygonal Robot	$\frac{220}{227}$
		9.3.2 Application: Coordinating Two Disc Robots	
	9.4		237
	9.5	Exercises	239
10	Env		24 1
	10.1	Envelopes of Curves in the Plane	241
		10.1.1 Representing the Envelope	
		10.1.2 Constructing the Envelope Diagram	
		10.1.3 The Envelope-Software Components	243

x	Cont	en	t:	S
X	cont	$_{ m en}$	Į	,;

	10.1.4 Using the Traits Classes	244		
10.2	Application: Nearest Jeep over Time			
	Envelopes of Surfaces in 3-Space			
	10.3.1 The Envelope-Traits Concept			
	10.3.2 Using the Envelope-Traits Classes			
10.4	Application: Locating the Farthest Point	257		
	Bibliographic Notes and Remarks			
10.6	Exercises	260		
11 Pro	spects	263		
	Arrangements on Curved Surfaces	263		
	Higher-Dimensional Arrangements			
	Fixed-Precision Geometric Computing			
	More Applications			
	Exercises			
Bibliography				
Index				