

Contents

1	Graphical modeling using L-systems	1
1.1	Rewriting systems	1
1.2	DOL-systems	3
1.3	Turtle interpretation of strings	6
1.4	Synthesis of DOL-systems	11
1.4.1	Edge rewriting	11
1.4.2	Node rewriting	13
1.4.3	Relationship between edge and node rewriting	18
1.5	Modeling in three dimensions	18
1.6	Branching structures	21
1.6.1	Axial trees	21
1.6.2	Tree OL-systems	23
1.6.3	Bracketed OL-systems	24
1.7	Stochastic L-systems	28
1.8	Context-sensitive L-systems	30
1.9	Growth functions	36
1.10	Parametric L-systems	40
1.10.1	Parametric OL-systems	41
1.10.2	Parametric 2L-systems	43
1.10.3	Turtle interpretation of parametric words	46
2	Modeling of trees	51
3	Developmental models of herbaceous plants	63
3.1	Levels of model specification	64
3.1.1	Partial L-systems	64
3.1.2	Control mechanisms in plants	65
3.1.3	Complete models	68
3.2	Branching patterns	70
3.3	Models of inflorescences	71
3.3.1	Monopodial inflorescences	71
3.3.2	Sympodial inflorescences	82
3.3.3	Polypodial inflorescences	86
3.3.4	Modified racemes	93

4	Phyllotaxis	99
4.1	The planar model	100
4.2	The cylindrical model	109
5	Models of plant organs	119
5.1	Predefined surfaces	119
5.2	Developmental surface models	120
5.3	Models of compound leaves	128
6	Animation of plant development	133
6.1	Timed DOL-systems	135
6.2	Selection of growth functions	139
6.2.1	Development of nonbranching filaments	140
6.2.2	Development of branching structures	142
7	Modeling of cellular layers	145
7.1	Map L-systems	145
7.2	Graphical interpretation of maps	150
7.3	Microsorium linguaeforme	153
7.4	Dryopteris thelypteris	162
7.5	Modeling spherical cell layers	166
7.6	Modeling 3D cellular structures	168
8	Fractal properties of plants	175
8.1	Symmetry and self-similarity	177
8.2	Plant models and iterated function systems	178
	Epilogue	191
	Appendix A Software environment for plant modeling	193
	A.1 A virtual laboratory in botany	193
	A.2 List of laboratory programs	198
	Appendix B About the figures	201
	Turtle interpretation of symbols	209
	Bibliography	211
	Index	225