

# Contents

## Part I Introduction

<b>1</b>	<b>Mathematical Background</b>	3
1.1	Sets and Sequences	3
1.1.1	Sets	3
1.1.2	Sequences	5
1.2	Relations	6
1.2.1	Relations	6
1.2.2	Functions	8
1.3	Graphs	9
1.3.1	Directed Graphs	9
1.3.2	Trees	10
<b>2</b>	<b>Formal Language Theory: Basics</b>	13
2.1	Languages	13
2.1.1	Language Families	17
2.2	Rewriting Systems as Basic Language Models	18
2.2.1	Equivalence	22
2.2.2	Determinism	22
2.3	Grammars	23
2.3.1	Grammars in General	23
2.3.2	How to Prove Context-Freeness	31
2.3.3	How to Disprove Context-Freeness	43
2.3.4	Parallel Grammars	45
2.4	Automata	49

## Part II Modern Grammars

<b>3</b>	<b>Regulated Grammars and Computation</b>	57
3.1	Context-Based Grammatical Regulation	58
3.1.1	Classical Grammars Viewed as Context-Regulated Grammars	58

3.1.2	Conditional Context Grammars .....	76
3.1.3	Random-Context Grammars .....	84
3.1.4	Forbidding Context Grammars .....	89
3.1.5	Semi-Conditional Context Grammars .....	103
3.1.6	Simple Semi-Conditional Context Grammars .....	107
3.2	Grammars Regulated by States .....	138
3.2.1	Definitions and Examples .....	138
3.2.2	Generative Power .....	140
3.3	Grammars Regulated by Control Languages .....	140
3.3.1	Definitions and Examples .....	141
3.3.2	Generative Power .....	145
3.4	Matrix Grammars .....	145
3.4.1	Definitions and Examples .....	145
3.4.2	Generative Power .....	147
3.4.3	Even Matrix Grammars .....	148
3.5	Programmed Grammars .....	161
3.5.1	Definitions and Examples .....	161
3.5.2	Generative Power .....	164
<b>4</b>	<b>Parallel Grammars and Computation .....</b>	<b>165</b>
4.1	Partially Parallel Grammars .....	166
4.1.1	Definitions and Examples .....	166
4.1.2	Generative Power .....	170
4.1.3	Normal Forms .....	171
4.1.4	Reduction .....	173
4.1.5	Economical Transformations .....	187
4.2	Totally Parallel Grammars .....	194
4.2.1	Context-Conditional ETOL Grammars .....	195
4.2.2	Forbidding ETOL Grammars .....	203
4.2.3	Simple Semi-Conditional ETOL Grammars .....	224
4.2.4	Left Random Context ETOL Grammars .....	238
<b>5</b>	<b>Jumping Grammars and Discontinuous Computation .....</b>	<b>257</b>
5.1	Jumping Grammars: Sequential Versions .....	258
5.1.1	Results .....	262
5.2	Jumping Grammars: Semi-Parallel Versions .....	273
5.2.1	Definitions .....	276
5.2.2	Results .....	277
<b>6</b>	<b>Algebra, Grammars, and Computation .....</b>	<b>307</b>
6.1	Sequential and Parallel Generation over Free Groups: Conceptualization .....	307
6.1.1	Definitions .....	308
6.2	Results: Computational Completeness .....	309
6.2.1	Conclusion .....	315

## Part III Modern Automata

<b>7</b>	<b>Regulated Automata and Computation</b>	319
7.1	Self-Regulating Automata	319
7.1.1	Self-Regulating Finite Automata	320
7.1.2	Self-Regulating Pushdown Automata	336
7.1.3	Open Problems	340
7.2	Regulated Acceptance with Control Languages	340
7.2.1	Finite Automata Regulated by Control Languages	341
7.2.2	Pushdown Automata Regulated by Control Languages	356
7.3	Self-Reproducing Pushdown Transducers	368
7.3.1	Definitions	368
7.3.2	Results	369
<b>8</b>	<b>Jumping Automata and Discontinuous Computation</b>	373
8.1	Definitions and Examples	374
8.1.1	Denotation of Language Families	376
8.2	Properties	376
8.2.1	Relations with Well-Known Language Families	378
8.2.2	Closure Properties	379
8.2.3	Decidability	382
8.2.4	An Infinite Hierarchy of Language Families	385
8.2.5	Left and Right Jumps	386
8.2.6	A Variety of Start Configurations	387
8.2.7	Relations Between Jumping Automata and Jumping Grammars	390
8.2.8	A Summary of Open Problems	391
<b>9</b>	<b>Deep Pushdown Automata and New Stack Structures</b>	393
9.1	Definitions and Examples	394
9.2	Accepting Power	396
9.3	Open Problems	405
9.3.1	Determinism	405
9.3.2	Generalization	406
<b>10</b>	<b>Algebra, Automata, and Computation</b>	407
10.1	Two-Sided Pushdown Acceptance over Free Groups:	
	Conceptualization	407
10.1.1	Definitions	409
10.2	Results: Computational Completeness	409
10.3	Conclusion	422

## Part IV Languages Defined in Combined Ways

<b>11 Language-Generating Automata and State-Controlled Computation</b>	425
11.1 Definitions and Examples	426
11.2 Results	427
<b>12 Multigenerative Grammar Systems and Parallel Computation</b>	433
12.1 Multigenerative Grammar Systems	434
12.2 Leftmost Multigenerative Grammar Systems	451

## Part V Modern Language Models Applied to Computation

<b>13 Applications and Their Perspectives in General</b>	467
13.1 General Comments on Applications in Computational Linguistics	467
13.2 General Comments on Applications in Computational Biology	469
<b>14 Applications in Computational Linguistics</b>	475
14.1 Syntax and Related Linguistic Terminology	476
14.1.1 Introduction	476
14.1.2 Terminology	478
14.1.3 Verbs	479
14.1.4 Personal Pronouns	480
14.2 Transformational Scattered Context Grammars	481
14.3 Scattered Context in English Syntax	483
14.3.1 Clauses with <i>neither</i> and <i>nor</i>	485
14.3.2 Existential Clauses	486
14.3.3 Interrogative Clauses	487
14.3.4 Question Tags	489
14.3.5 Generation of Grammatical Sentences	492
<b>15 Applications in Computational Biology</b>	495
15.1 DNA Processing with Jumping Scattered Context Derivations	495
15.2 Biological Development and Its Grammatical Simulation	496
15.3 Simulation of Biological Development and Its Implementation	502

## Part VI Conclusion

<b>16 Concluding Remarks</b>	513
16.1 Summary	513
16.2 Modern Trends	516
16.2.1 An Algebraic Approach to Modern Versions of Grammars and Automata	516
16.2.2 Combining Grammars and Automata	516
16.2.3 Modern Translation-Defining Models	517
16.2.4 Open Problem Areas	517

16.3	Bibliographical Remarks .....	519
16.3.1	Context-Based Grammatical Models .....	519
16.3.2	Rule-Based Grammatical Regulation .....	520
16.3.3	Modern Parallel Grammars .....	521
16.3.4	Modern Versions of Grammar Systems .....	521
16.3.5	Modern Versions of Automata .....	521
16.3.6	Discontinuous Rewriting .....	522
<b>Bibliography .....</b>		<b>523</b>
<b>Index to Models and Language Families They Define .....</b>		<b>535</b>
<b>Subject Index .....</b>		<b>539</b>



<http://www.springer.com/978-3-319-63099-1>

Modern Language Models and Computation

Theory with Applications

Meduna, A.; Soukup, O.

2017, XIX, 548 p. 20 illus., Hardcover

ISBN: 978-3-319-63099-1