

Automata Theory with Modern Applications

With contributions by Tom Head

JAMES A. ANDERSON

University of South Carolina Upstate



CAMBRIDGE
UNIVERSITY PRESS

Contents

<i>Preface</i>	page vii
1 Introduction	1
1.1 Sets	1
1.2 Relations	6
1.3 Functions	12
1.4 Semigroups	16
2 Languages and codes	23
2.1 Regular languages	23
2.2 Retracts (Optional)	29
2.3 Semiretracts and lattices (Optional)	34
3 Automata	37
3.1 Deterministic and nondeterministic automata	37
3.2 Kleene's Theorem	52
3.3 Minimal deterministic automata and syntactic monoids	72
3.4 Pumping Lemma for regular languages	84
3.5 Decidability	86
3.6 Pushdown automata	89
3.7 Mealy and Moore machines	99
4 Grammars	114
4.1 Formal grammars	114
4.2 Chomsky normal form and Greibach normal form	138
4.3 Pushdown automata and context-free languages	149
4.4 The Pumping Lemma and decidability	162
5 Turing machines	169
5.1 Deterministic Turing machines	169

5.2	Nondeterministic Turing machines and acceptance of context-free languages	190
5.3	The halting problem for Turing machines	194
5.4	Undecidability problems for context-free languages	200
6	A visual approach to formal languages	210
6.1	Introduction	210
6.2	A minimal taste of word combinatorics	212
6.3	The spectrum of a word with respect to a language	214
6.4	The spectral partition of Σ^+ and the support of L	216
6.5	Visualizing languages	217
6.6	The sketch parameters of a language	221
6.7	Flag languages	223
6.8	Additional tools from word combinatorics	224
6.9	Counting primitive words in a regular language	225
6.10	Algorithmic sketching of regular languages	227
7	From biopolymers to formal language theory	231
7.1	Introduction	231
7.2	Constructing new words by splicing together pairs of existing words	232
7.3	The motivation from molecular biology	233
7.4	Splicing rules, schemes, systems, and languages	236
7.5	Every splicing language is a regular language	239
7.6	The syntactic monoid of a regular language L allows an effective determination of the set of all splicing rules that respect L	241
7.7	It is algorithmically decidable whether a given regular language is a reflexive splicing language	242
	Appendix A Cardinality	245
	Appendix B Co-compactness Lemma	247
	<i>References</i>	249
	<i>Further reading</i>	251
	<i>Index</i>	253