

Contents

<i>Preface</i>	<i>page</i>	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