Contents

Introduction **11**

1 Preliminaries **17**
1.1 Rational languages 18
1.2 Rational transductions 20
1.3 Decision Problems 21

2 Control Languages **23**
2.1 Subclasses of rational transductions 24
2.2 Formal definitions 25
2.3 Effective control languages 26
2.4 Undecidable problems 27
2.4.1 Intersection problem 28
2.4.2 Equivalence problem 31

3 Resynchronisers **33**
3.1 Synchronisations and resynchronisers 34
3.2 Decision Problems Modulo Resynchronisers 35
3.2.1 Reachability games 37
3.2.2 Alternating Turing machines 39
3.3 Bounded delay resynchronisers 42
3.4 Complexity 45
3.5 Completeness of bounded delay decision problems 48

4 Finite-valued Transducers **53**
4.1 Introduction 54
4.2 Preliminary results 55
4.2.1 Stable factors 56
4.2.2 Finding stable factors 58
4.3 Containment and equivalence 60
4.4 Sequential uniformisation 62
4.4.1 The stable iterator 63
4.4.2 Constructing an infinite sequential uniformiser 67

5 Max-plus Automata **69**
5.1 Determinisation of max-plus automata 70
5.2 Formal notions and definitions 71
5.2.1 Max-plus automata 71
5.2.2 Determinisation by pruning 72

5.2.3 Delay determinisation 73
5.3 Deciding the k-determinisation problem 74
5.4 Lower bound 77
5.5 Completeness for determinisation 80

6 Reversible Transducers **83**
6.1 Reversible systems 84
6.2 Formal notions and definitions 85
6.2.1 Two-way automata 85
6.2.2 Two-way transducers 87
6.2.3 Streaming string transducers 87
6.3 Composition of reversible transducers 88
6.4 Making transducers reversible 90
6.4.1 Codeterministic one-way automata 91
6.4.2 Cosequential one-way transducers 93
6.4.3 Two-way transducers 97
6.4.4 Streaming string transducers 100