

Cambridge University Press

978-0-521-89833-1 - Graph Structure and Monadic Second-Order Logic: A Language-Theoretic Approach

Bruno Courcelle and Joost Engelfriet

[Table of Contents](#)[More information](#)

Contents

<i>Foreword by Maurice Nivat</i>	<i>page xi</i>
----------------------------------	----------------

Introduction	1
1 Overview	16
1.1 Context-free grammars	17
1.2 Inductive sets of properties and recognizability	28
1.3 Monadic second-order logic	40
1.4 Two graph algebras	46
1.5 Fixed-parameter tractability	53
1.6 Decidability of monadic second-order logic	56
1.7 Graph transductions	58
1.8 Monadic second-order logic with edge set quantifications	68
1.9 Relational structures	74
1.10 References	78
2 Graph algebras and widths of graphs	80
2.1 Algebras and terms	81
2.2 Graphs	87
2.3 The HR algebra of graphs with sources	99
2.4 Tree-decompositions	121
2.5 The VR algebra of simple graphs with ports	144
2.6 Many-sorted graph algebras	176
2.7 References	185
3 Equational and recognizable sets in many-sorted algebras	188
3.1 The equational sets of an algebra	189
3.2 Transformations of equation systems	206
3.3 Intermezzo on automata	221
3.4 The recognizable sets of an algebra	227
3.5 References	259

Cambridge University Press

978-0-521-89833-1 - Graph Structure and Monadic Second-Order Logic: A Language-Theoretic Approach

Bruno Courcelle and Joost Engelfriet

Table of Contents

[More information](#)

viii

Contents

4	Equational and recognizable sets of graphs	260
4.1	HR-equational sets of graphs	261
4.2	HR-recognizable sets of graphs	281
4.3	VR-equational sets of simple graphs	292
4.4	VR-recognizable sets of simple graphs	305
4.5	HR- and VR-equational and recognizable sets	312
4.6	References	313
5	Monadic second-order logic	315
5.1	Relational structures and logical languages	315
5.2	Graph properties expressible in monadic second-order logic	331
5.3	Monadic second-order logic and recognizability	358
5.4	Decidable monadic second-order theories	408
5.5	Logical characterization of recognizability	409
5.6	Equivalences of logical formulas	416
5.7	References	425
6	Algorithmic applications	427
6.1	Fixed-parameter tractable algorithms for model-checking	428
6.2	Decomposition and parsing algorithms	433
6.3	Monadic second-order formulas compiled into finite automata	439
6.4	Other monadic second-order problems solved with automata	493
6.5	References	503
7	Monadic second-order transductions	505
7.1	Definitions and basic properties	506
7.2	The Equationality Theorem for the VR algebra	534
7.3	Graph transductions using incidence graphs	555
7.4	The Equationality Theorem for the HR algebra	559
7.5	Decidability of monadic second-order satisfiability problems	566
7.6	Questions about logical characterizations of recognizability	574
7.7	References	576
8	Transductions of terms and words	578
8.1	Terminology	580
8.2	Tree-walking transducers	585
8.3	The basic characterization	591
8.4	From jumping to walking	593
8.5	From global to local tests	595
8.6	Multi bottom-up tree-to-word transducers	604
8.7	Attribute grammars and macro tree transducers	610
8.8	Nondeterminism	613
8.9	VR-equational sets of terms and words	614
8.10	References	618

Cambridge University Press

978-0-521-89833-1 - Graph Structure and Monadic Second-Order Logic: A Language-Theoretic Approach

Bruno Courcelle and Joost Engelfriet

Table of Contents

[More information](#)

	<i>Contents</i>	ix
9		621
Relational structures		621
9.1	Two types of ternary relational structures related to ordered sets	622
9.2	Relational structures of bounded tree-width	629
9.3	Terms denoting relational structures	636
9.4	Sparse relational structures	651
9.5	References	685
	Conclusion and open problems	686
	<i>References</i>	691
	<i>Index of notation</i>	711
	<i>Index</i>	721