

Contents

List of Figures	xiii
List of Tables	xv
1 Introduction	1
1.1 Modal, temporal, and hybrid languages	1
1.2 Towards a systematic study of the complexity of hybrid logics . .	3
1.3 The complexity of multi-modal hybrid logics	5
1.4 Legend to this thesis	6
2 Preliminaries	7
2.1 Hybrid logic	7
2.1.1 Syntax	7
2.1.2 Semantics	8
2.1.3 Other operators of interest	10
2.1.4 Properties of models and frames	11
2.1.5 Hybrid languages and their decision problems	12
2.1.6 Bounded model properties	13
2.2 First-order logic	14
2.2.1 Basic concepts	14
2.2.2 Fragments of FOL and the standard translation	16
2.3 Computational complexity	17
2.4 Tools used for establishing complexity bounds	18
2.4.1 Quantified Boolean Formulae	18
2.4.2 Propositional dynamic logic for sibling-ordered trees . . .	19
2.4.3 First-order logic over strings	21
2.4.4 Tilings	21
3 Expressivity	25
3.1 Towards a hierarchy of hybrid languages	25
3.2 Hierarchies over restricted frame classes	29

4	Model Checking	31
4.1	Complete frames and above	31
4.2	Natural numbers and above	34
5	Satisfiability	35
5.1	Introduction	35
5.2	A map of the results for satisfiability	36
5.3	Arbitrary frames	42
5.4	Transitive frames	46
5.4.1	Binder-free until/since languages	46
5.4.2	Languages with binders	51
5.5	Transitive trees	55
5.5.1	Binder-free until/since languages	55
5.5.2	Languages with binders	58
5.6	Linear frames	61
5.7	Natural numbers	65
5.8	Frames with equivalence relations	66
5.8.1	Languages without binders	66
5.8.2	Languages with binders and without E	67
5.8.3	The full language	71
5.8.4	Pure languages with binders	82
6	Satisfiability of Multi-Modal Downarrow Logic	85
6.1	Introduction	85
6.2	Linear orders and above	89
6.3	Frames with equivalence relations and above	95
7	Conclusion	101
	Bibliography	103