

Contents

1	Introduction	1
1.1	Contributions	1
1.2	Related Work	4
1.3	Outline	4
2	Introductory Example	7
2.1	Stacks of Natural Numbers	7
2.2	Transforming Functional Signatures into Class Signatures	7
2.3	Transforming Terms into their Object-Oriented Counterpart	10
2.4	Transforming Axioms into their Object-Oriented Counterpart	11
I	Foundations	13
3	Algebraic Specifications	15
3.1	Syntax	15
3.1.1	Signatures	15
3.1.2	Terms	18
3.1.3	Formulas and Specifications	20
3.2	Semantics	21
3.2.1	Σ -Algebras	21
3.2.2	Models	22
4	Object-Oriented Specifications	25
4.1	System Model	25
4.1.1	Objects, Identities, States, and Types	26
4.1.2	Lifecycle	26
4.1.3	State Space	26
4.1.4	Methods	27

4.1.5	Classes and Object-Oriented Systems	30
4.1.6	Related System Models	30
4.2	Syntax	31
4.2.1	Class Signatures	32
4.2.2	Method Application Structures	34
4.2.3	Formulas and Specifications	38
4.3	Semantics	39
4.3.1	Interpretation of Class Signatures	39
4.3.2	Evaluating Sequences of Method Applications	42
4.3.3	Models	45
4.4	Graphical Representation with UML	46
4.4.1	Class Signatures	46
4.4.2	Method Application Structures	47
4.4.3	Formulas over Method Application Structures	49

II Transformations 51

5	Transforming Functional Signatures into Class Signatures	53
5.1	Overview	53
5.1.1	Relating Sorts and Type Names	54
5.1.2	Relating Function Symbols and Method Symbols	54
5.1.3	Classification of Function Symbols	54
5.2	Transforming Function Symbols into Method Symbols	55
5.2.1	Lifecycle of Objects	55
5.2.2	Single-Dispatching	57
5.2.3	Object Identity	57
5.2.4	Summary	59
5.3	Transforming Functional Signatures into Class Signatures	60
5.3.1	Transformation Mapping	61
5.3.2	Transformation of Signatures with a Singleton Non-primitive Sort	61
5.3.3	Transformation of Linear Signatures	62
5.3.4	Transformation of Structured Signatures	64

6	Transforming Linear Terms and Equations between Linear Terms	67
6.1	Transforming Linear Terms into Method Application Structures	67
6.1.1	Preliminaries	67
6.1.2	Transformation of Linear Terms	69
6.1.3	Restriction of the Transformation to Linear Terms	72
6.2	Transforming Equations into Formulas over Method Application Structures	73
6.3	Putting the Transformations Together	74
6.3.1	Transforming Algebraic Specifications into Object-Oriented Specifications	74
6.3.2	Results	74
III	Case Study and Mechanization	77
7	Case Study: Stacks of Natural Numbers	79
7.1	Overview	79
7.2	Design Space	80
7.3	Transformations	81
7.3.1	Basic Assumptions	81
7.3.2	Scenario 1	82
7.3.3	Scenario 2	86
7.3.4	Scenario 3	89
7.3.5	Summary	92
7.4	Object-Oriented Classes	93
7.4.1	Preliminaries	93
7.4.2	Scenario 1	93
7.4.3	Scenario 2	95
7.4.4	Scenario 3	98
7.5	Signature with Multiple Types of Interest	100
7.5.1	Signature	100
7.5.2	Scenario	101
7.5.3	Signature Transformation	103

8	The Tool ASIOS	107
8.1	System Description	107
8.1.1	Characteristic Features	107
8.1.2	External Data Structures	108
8.2	Architecture	108
8.2.1	Overview	108
8.2.2	CASL editor	110
8.2.3	Signature Transformation	111
8.2.4	Transformation of Terms and of Equations between Terms	113
8.3	Workflow and Experiences	113
8.3.1	Workflow	113
8.3.2	First Experiences	114
9	Conclusion	117
9.1	Topics and Results of the Thesis	117
9.2	Application to the Development of Components	119
9.3	Future Work	120
	Bibliography	123
A	Mathematical Background	133
A.1	Sets	133
A.2	Mappings	133
A.3	Sequences	135
A.4	Indexed Families	136
B	Implementations of Stacks in Java	139
C	Proofs	143
C.1	Semantic Relation	143
C.2	Transformation of Linear Terms	147
C.3	Transformation of Equations between Terms	154
C.4	Transformation of Algebraic Specifications	155
	Curriculum Vitae	159