

Contents

Part I. Syntax

1. The Parametric λ-Calculus	3
1.1 The Language of λ -Terms	3
1.2 The $\lambda\Delta$ -Calculus	6
1.2.1 Proof of Confluence and Standardization Theorems ...	14
1.3 Δ -Theories	21
2. The Call-by-Name λ-Calculus	25
2.1 The Syntax of $\lambda\Lambda$ -Calculus	25
2.1.1 Proof of Λ -Solvability Theorem	27
2.1.2 Proof of Böhm's Theorem	28
3. The Call-by-Value λ-Calculus	35
3.1 The Syntax of the $\lambda\Gamma$ -Calculus	35
3.1.1 $\Xi\ell$ -Confluence and $\Xi\ell$ -Standardization	41
3.1.2 Proof of Potential Γ -Valuability and Γ -Solvability Theorems	43
3.1.3 Proof of Γ -Separability Theorem	49
3.2 Potentially Γ -Valuable Terms and Λ -Reduction	58
4. Further Reading	61

Part II. Operational Semantics

5. Parametric Operational Semantics	65
5.1 The Universal Δ -Reduction Machine	70
6. Call-by-Name Operational Semantics	73
6.1 H -Operational Semantics	73
6.2 N -Operational Semantics	77
6.3 L -Operational Semantics	81
6.3.1 An Example	85

7. Call-by-Value Operational Semantics	89
7.1 V-Operational Semantics	89
7.1.1 An Example	93
8. Operational Extensionality	95
8.1 Operational Semantics and Extensionality	95
8.1.1 Head-Discriminability	99
9. Further Reading	101

Part III. Denotational Semantics

10. $\lambda\Delta$-Models	105
10.1 Filter $\lambda\Delta$ -Models	108
11. Call-by-Name Denotational Semantics	119
11.1 The Model \mathcal{H}	119
11.1.1 The \leq_∞ -Intersection Relation	129
11.1.2 Proof of the \mathcal{H} -Approximation Theorem	132
11.1.3 Proof of Semiseparability, \mathcal{H} -Discriminability and \mathcal{H} -Characterization Theorems	136
11.2 The Model \mathcal{N}	144
11.2.1 The \leq_\otimes -Intersection Relation	151
11.2.2 Proof of \mathcal{N} -Approximation Theorem	154
11.2.3 Proof of \mathcal{N} -Discriminability and \mathcal{N} -Characterization Theorems	157
11.3 The Model \mathcal{L}	162
11.3.1 Proof of \mathcal{L} -Approximation Theorem	168
11.3.2 Proof of Theorems 11.3.15 and 11.3.16	170
11.4 A Fully Abstract Model for the L -Operational Semantics	172
11.5 Crossing Models	178
11.5.1 The Model \mathcal{H}	178
11.5.2 The Model \mathcal{N}	179
11.5.3 The Model \mathcal{L}	179
12. Call-by-Value Denotational Semantics	181
12.1 The Model \mathcal{V}	181
12.1.1 The \leq_\vee -Intersection Relation	190
12.1.2 Proof of Theorem 12.1.6	192
12.1.3 Proof of the \mathcal{V} -Approximation Theorem	195
12.1.4 Proof of Theorems 12.1.24 and 12.1.25	198
12.2 A Fully Abstract Model for the V -Operational Semantics	201

13. Filter $\lambda\Delta$ -Models and Domains 207

 13.1 Domains 207

 13.1.1 \mathcal{H} as Domain 214

 13.1.2 \mathcal{N} as Domain 216

 13.1.3 \mathcal{L} as Domain 217

 13.1.4 \mathcal{V} as Domain 218

 13.1.5 Another Domain 219

14. Further Reading 221

Part IV. Computational Power

15. Preliminaries 225

 15.1 Kleene's Recursive Functions 225

 15.2 Representing Data Structures 227

16. Representing Functions 233

 16.1 Call-by-Name Computational Completeness 233

 16.2 Call-by-Value Computational Completeness 237

 16.3 Historical Remarks 239

Bibliography 241

Index 247