Table of Contents

Preface **vii**
by Masako Takahashi, Mitsuhiro Okada, and Mariangiola Dezani-Ciancaglini

Chapter 1. A primer on proofs and types **1**
by Masako Takahashi
1. Introduction 1
2. Formal proof systems 3
3. Computable functions 14
4. λ-calculus 20
5. Type systems 25
References 42

Chapter 2. Intersection types, λ-models, and Böhm trees **45**
by Mariangiola Dezani-Ciancaglini, Elio Giovannetti, and Ugo de'Liguoro
1. Introduction 45
2. Some examples of typings 49
3. Types and β-convertibility 52
4. Unsolvable terms and typing 55
5. Types and approximants 56
6. The characterization theorems 58
7. Subtyping 63
8. Subtyping and η-rule 64
9. The system BCD 67
10. Semantics of type assignments 70
11. Filter models and completeness 74
12. Filter models and domains 79
13. Types and Böhm trees 83
14. Further readings 90
References 91

Chapter 3. Syntax and semantics of type assignment systems **99**
by Hirofumi Yokouchi
1. Introduction 99
2. Function types 102
3. Polymorphic types 111
4. Intersection types 115
5. Union and existential quantifier 122
6. Sequent-style formulations 124
7. Analysis of type assignment by the sequent-style formulations 131
References 138

Chapter 4. Inference based analyses of functional programs: dead-code and strictness **143**
by Mario Coppo, Ferruccio Damiani, and Paola Giannini
1. Introduction 143
2. The language PCFP 148
3. A framework for non-standard type inference 153
4. Instantiating the framework 159
5. Dead-code analysis 159
6. Strictness analysis 167
7. Final Remarks 172
References 172

Chapter 5. Constructivization via approximations and examples **177**
by Stefano Baratella and Stefano Berardi
1. Introduction 177
2. Preliminaries 180
3. The constructive interpretation 183
4. Step-by-step proof interpretation 186
5. Direct interpretation 193
References 204

Chapter 6. Proof-theoretic methods in nonclassical logic — an introduction **207**
by Hiroakira Ono
1. Introduction 207
2. Sequent calculi for nonclassical logic 210
3. Cut elimination theorem 217
4. Decision problems for the classical and the intuitionistic logics 226
5. Decision problems for substructural logics 233
6. Interpolation property 239
7. Variable sharing and variable separation 247
8. A short remark 251
References 252

Chapter 7. An introduction to linear logic: expressiveness and phase semantics **255**
by Mitsuhiro Okada
1. Introduction 255
2. Syntax of linear logic 257
3. Phase semantics, completeness and cut-elimination of linear logic 266
4. Linear logic as concurrent process calculus by the proof search paradigm 273
5. Naive phase semantics and completeness of Petri net specification system 282
References 293