Contents

Preface — VII

Dependencies between the chapters — XVII

Detailed plan — XIX

Acknowledgments and short history of this book — XXV

Notation conventions — XXVII

1 Basic transformations of categories: Hierarchy of *n*-dimensional levels — 1
1.1 The *n*-dimensional levels: A nonset-based definition of natural numbers — **1**
1.2 Comma lifting for *n*-dimensional levels — **6**
1.3 Introduction to comma-induction in the *n*-dimensional hierarchy — **16**
1.4 Comma-induction of the adjunctions — **20**

2 Comma-propagation transformations: Global categorial symmetries — 29
2.1 Introduction to general comma-propagation — **29**
2.2 Comma-propagation of functors and natural transformations — **34**
2.3 Comma-propagation of (co)limits — **40**
2.4 Example: Comma-propagation and infinite hierarchy of small-complete categories — **50**
2.5 An analogy between physical and abstract categorial Global symmetries: Adjunctions-as-fields — **57**
2.5.1 Analogy between adjunctions and metric tensor field with Einstein–Hilbert action — **60**
2.5.2 Comma-propagation transformation symmetries — **65**

3 Arrows-to-objects conceptual transformation: Internal categorial symmetry — 71
3.1 Introduction to categorial internal symmetry of primitive categorial concepts — **71**
3.2 Internal symmetry and metacategory — **77**
3.3 Conceptually closed categories: A topology — **83**
3.4 Symmetry-extended categories — **94**
3.5 Symmetry hierarchy upper bound: Imploded categories — **101**

4 Internal symmetry and logical deduction — 111
4.1 Natural deduction system — **111**
4.1.1 First solution for tagging techniques of natural deduction — **111**

Bibliografische Informationen
https://d-nb.info/1277762252

digitalisiert durch DEUTSCHE NATIONAL BIBLIOTHEK

4.1.2 Sequent-based solution for tagging techniques — **116**
4.2 Definition of symmetry-extended category **ND** for natural deduction — **119**
4.2.1 The properties of the covariant implication functor — **125**
4.2.2 Local Cartesian Closed Adjunction (pCCC) — **128**
4.2.3 The *n*-dimensional levels of natural deduction categories — **133**
4.3 Symmetry-extended category **IC** for propositional intuitionistic calculus — **138**

5 Internal symmetry and lambda calculus — 144
5.1 Introduction to lambda calculus — **144**
5.2 Reflexive objects in the Cartesian closed categories — **149**
5.3 Conceptually-closed CCC and its subcategories of idempotents — **156**
5.4 Internal categorial symmetry and fixed-point operators — **166**
5.5 Topological K-theory, idempotent completion and internal categorial symmetry — **169**

6 Internal symmetry and theory of processes: Strong bisimulation of computation trees — 173
6.1 Introduction to transition systems and their bisimulations — **173**
6.2 Regular languages, automata and internal categorial symmetry — **177**
6.3 Symmetry-extended category of finite labeled trees — **183**
6.4 Internal symmetry of the category of relations — **191**
6.5 Transition systems as fixed points in the *n*-dimensional level $\mathbf{Rel}_3$ — **196**
6.6 Strong bisimulations as fixed points in the *n*-dimensional level $\mathbf{Rel}_3$ — **201**
6.6.1 Mathematics via symmetry: Reduction of many valued into 2-valued logic — **207**
6.6.2 Many-valued knowledge invariance through modal logic transformations: Semantic reflection — **212**

7 Internal symmetry and data integration theory — 220
7.1 **DB** (Database) category — **220**
7.1.1 Morphism properties of **DB** category — **235**
7.1.2 Power-view endofunctor and monad T — **249**
7.1.3 Duality — **254**
7.2 Objects of **DB**: Basic operations and equivalence relations — **257**
7.2.1 Data federation operator in **DB** — **257**
7.2.2 Data separation operator in **DB** — **258**
7.2.3 The (strong) behavioral equivalence for databases — **261**
7.2.4 Weak observational equivalence for databases — **263**
7.3 Internal categorial symmetry of **DB** category — **266**
7.3.1 (Co)products — **270**
7.3.2 (Co)Limits and exponentiation — **274**

7.3.3 Kleisli semantics for database mappings — **282**
7.4 Partial ordering for databases — **288**
7.4.1 Matching tensor product — **292**
7.4.2 Merging operator — **295**
7.4.3 Universal algebra considerations — **298**
7.4.4 Algebraic database lattice — **302**
7.5 Enrichment — **313**
7.5.1 **DB** is a V-category enriched over itself — **315**
7.5.2 Internalized Yoneda embedding — **320**

A Appendix — 323
A.1 Introduction to lattices, algebras and logics — **323**
A.1.1 Introduction to deductive logic and binary sequent calculus — **327**
A.1.2 Introduction to first-order logic and Tarski's interpretations — **329**
A.1.3 Introduction to multimodal logics and Kripke semantics — **333**
A.2 Basic category theory — **334**
A.3 Introduction to RDB, database mappings and **DB** category — **348**
A.3.1 Basic database concepts — **351**
A.3.2 Database observations: Idempotent power-view operator — **357**
A.3.3 Logic versus algebras: Categorification by operads — **360**
A.3.4 Sketches and functors into the **DB** category — **363**
A.3.5 Semantics of DB schema mappings: Information fluxes — **370**
A.4 Introduction to field theory and symmetries — **381**
A.4.1 Vector fields on curved differentiable manifolds — **388**
A.4.2 Transformation of coordinates — **392**

Bibliography — 395

Index — 403