

# Category Theory In Context Aurora Dover Modern Ma

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## CAITLYN DILLON

**Roar** Springer Science & Business Media

This book surveys the fundamental ideas of algebraic topology. The first part covers the fundamental group, its definition and application in the study of covering spaces. The second part turns to homology theory including cohomology, cup products, cohomology operations and topological manifolds. The final part is devoted to Homotopy theory, including basic facts about homotopy groups and applications to obstruction theory. **Basic Category Theory** Springer Science & Business Media Introduction to concepts of category theory — categories, functors, natural transformations, the Yoneda lemma, limits and colimits, adjunctions, monads — revisits a broad range of mathematical examples from the categorical perspective. 2016 edition.

**Topology** MIT Press

The language of  $\infty$ -categories provides an insightful new way of expressing many results in higher-dimensional mathematics but can be challenging for the uninitiated. To explain what exactly an  $\infty$ -category is requires various technical models, raising the question of how they might be compared. To overcome this, a model-independent approach is desired, so that theorems proven with any model would apply to them all. This text develops the theory of  $\infty$ -categories from first principles in a model-independent fashion using the axiomatic framework of an  $\infty$ -cosmos, the universe in which  $\infty$ -categories live as objects. An  $\infty$ -cosmos is a fertile setting for the formal category theory of  $\infty$ -categories, and in this way the foundational proofs in  $\infty$ -category theory closely resemble the classical foundations of ordinary category theory. Equipped with exercises and appendices with background material, this first introduction is meant for students and researchers who have a strong foundation in classical 1-category theory.

**Topos Theory** Courier Corporation

Category theory has provided the foundations for many of the twentieth century's greatest advances in pure mathematics. This concise, original text for a one-semester course on the subject is derived from courses that author Emily Riehl taught at Harvard and Johns Hopkins Universities. The treatment introduces the essential concepts of category theory: categories, functors, natural transformations, the Yoneda lemma, limits and colimits, adjunctions, monads, and other topics. Suitable for advanced undergraduates and graduate students in mathematics, the text provides tools for understanding and attacking difficult problems in algebra, number theory, algebraic geometry, and algebraic

topology. Drawing upon a broad range of mathematical examples from the categorical perspective, the author illustrates how the concepts and constructions of category theory arise from and illuminate more basic mathematical ideas. Prerequisites are limited to familiarity with some basic set theory and logic.

**An Invitation to Applied Category Theory** Clarendon Press

This book develops abstract homotopy theory from the categorical perspective with a particular focus on examples. Part I discusses two competing perspectives by which one typically first encounters homotopy (co)limits: either as derived functors definable when the appropriate diagram categories admit a compatible model structure, or through particular formulae that give the right notion in certain examples. Emily Riehl unifies these seemingly rival perspectives and demonstrates that model structures on diagram categories are irrelevant. Homotopy (co)limits are explained to be a special case of weighted (co)limits, a foundational topic in enriched category theory. In Part II, Riehl further examines this topic, separating categorical arguments from homotopical ones. Part III treats the most ubiquitous axiomatic framework for homotopy theory - Quillen's model categories. Here, Riehl simplifies familiar model categorical lemmas and definitions by focusing on weak factorization systems. Part IV introduces quasi-categories and homotopy coherence.

**An Invitation to Algebraic Geometry** Courier Corporation

This book is an attempt to give a systematic presentation of both logic and type theory from a categorical perspective, using the unifying concept of fibred category. Its intended audience consists of logicians, type theorists, category theorists and (theoretical) computer scientists.

**Algebras and Representation Theory** Cambridge University Press

Designed for the intellectually curious, this book provides a solid foundation in basic probability theory in a charming style, without technical jargon. This text will immerse the reader in a mathematical view of the world, and teach them techniques to solve real-world problems both inside and outside the casino.

**Category Theory** Cambridge University Press

Monoidal category theory serves as a powerful framework for describing logical aspects of quantum theory, giving an abstract language for parallel and sequential composition, and a conceptual way to understand many high-level quantum phenomena. This text lays the foundation for this categorical quantum mechanics, with an emphasis on the graphical calculus which makes computation intuitive. Biproducts and dual objects are introduced and used to model superposition and entanglement, with quantum teleportation studied abstractly using these structures. Monoids, Frobenius structures and Hopf

algebras are described, and it is shown how they can be used to model classical information and complementary observables. The CP construction, a categorical tool to describe probabilistic quantum systems, is also investigated. The last chapter introduces higher categories, surface diagrams and 2-Hilbert spaces, and shows how the language of duality in monoidal 2-categories can be used to reason about quantum protocols, including quantum teleportation and dense coding. Prior knowledge of linear algebra, quantum information or category theory would give an ideal background for studying this text, but it is not assumed, with essential background material given in a self-contained introductory chapter. Throughout the text links with many other areas are highlighted, such as representation theory, topology, quantum algebra, knot theory, and probability theory, and nonstandard models are presented, such as sets and relations. All results are stated rigorously, and full proofs are given as far as possible, making this book an invaluable reference for modern techniques in quantum logic, with much of the material not available in any other textbook.

**Categorical Homotopy Theory** Springer

An introduction to category theory as a rigorous, flexible, and coherent modeling language that can be used across the sciences. Category theory was invented in the 1940s to unify and synthesize different areas in mathematics, and it has proven remarkably successful in enabling powerful communication between disparate fields and subfields within mathematics. This book shows that category theory can be useful outside of mathematics as a rigorous, flexible, and coherent modeling language throughout the sciences. Information is inherently dynamic; the same ideas can be organized and reorganized in countless ways, and the ability to translate between such organizational structures is becoming increasingly important in the sciences. Category theory offers a unifying framework for information modeling that can facilitate the translation of knowledge between disciplines. Written in an engaging and straightforward style, and assuming little background in mathematics, the book is rigorous but accessible to non-mathematicians. Using databases as an entry to category theory, it begins with sets and functions, then introduces the reader to notions that are fundamental in mathematics: monoids, groups, orders, and graphs—categories in disguise. After explaining the “big three” concepts of category theory—categories, functors, and natural transformations—the book covers other topics, including limits, colimits, functor categories, sheaves, monads, and operads. The book explains category theory by examples and exercises rather than focusing on theorems and proofs. It includes more than 300 exercises, with solutions. Category Theory for the Sciences is intended to create a bridge between the vast array of

mathematical concepts used by mathematicians and the models and frameworks of such scientific disciplines as computation, neuroscience, and physics.

#### **Undergraduate Commutative Algebra** Tor Teen

Grothendieck's beautiful theory of schemes permeates modern algebraic geometry and underlies its applications to number theory, physics, and applied mathematics. This simple account of that theory emphasizes and explains the universal geometric concepts behind the definitions. In the book, concepts are illustrated with fundamental examples, and explicit calculations show how the constructions of scheme theory are carried out in practice.

#### **Symmetry** Springer Science & Business Media

The Handbook of Categorical Algebra is designed to give, in three volumes, a detailed account of what should be known by everybody working in, or using, category theory. As such it will be a unique reference. The volumes are written in sequence, with the first being essentially self-contained, and are accessible to graduate students with a good background in mathematics. In particular, Volume 1, which is devoted to general concepts, can be used for advanced undergraduate courses on category theory.

#### **Elements of $\infty$ -Category Theory** Cambridge University Press

Type theory is a fast-evolving field at the crossroads of logic, computer science and mathematics. This gentle step-by-step introduction is ideal for graduate students and researchers who need to understand the ins and outs of the mathematical machinery, the role of logical rules therein, the essential contribution of definitions and the decisive nature of well-structured proofs. The authors begin with untyped lambda calculus and proceed to several fundamental type systems, including the well-known and powerful Calculus of Constructions. The book also covers the essence of proof checking and proof development, and the use of dependent type theory to formalise mathematics. The only prerequisite is a basic knowledge of undergraduate mathematics. Carefully chosen examples illustrate the theory throughout. Each chapter ends with a summary of the content, some historical context, suggestions for further reading and a selection of exercises to help readers familiarise themselves with the material.

#### **Knot Theory and Its Applications** MIT Press

Raised to rule, despite not having the abilities her ancestors did, Aurora becomes betrothed to a prince who possesses the magic needed to keep the kingdom safe.

#### **Introduction to Art: Design, Context, and Meaning** Cambridge University Press

New and classical results in computational complexity, including interactive proofs, PCP, derandomization, and quantum computation. Ideal for graduate students.

#### **Noncommutative Geometry** Harper Collins

An array of general ideas useful in a wide variety of fields. Starting from the foundations, this book illuminates the concepts of category, functor, natural transformation, and duality. It then turns to adjoint functors, which provide a description of universal constructions, an analysis of the representations of functors by sets of morphisms, and a means of manipulating direct and inverse limits. These categorical concepts are extensively

illustrated in the remaining chapters, which include many applications of the basic existence theorem for adjoint functors. The categories of algebraic systems are constructed from certain adjoint-like data and characterised by Beck's theorem. After considering a variety of applications, the book continues with the construction and exploitation of Kan extensions. This second edition includes a number of revisions and additions, including new chapters on topics of active interest: symmetric monoidal categories and braided monoidal categories, and the coherence theorems for them, as well as 2-categories and the higher dimensional categories which have recently come into prominence.

#### **Fat Chance** Oxford University Press

A mathematician takes us on "a pilgrimage through the uncanny world of symmetry [in] a dramatically presented and polished treasure of theories" (Kirkus Reviews). Symmetry is all around us. Of fundamental significance to the way we interpret the world, this unique, pervasive phenomenon indicates a dynamic relationship between objects. Combining a rich historical narrative with his own personal journey as a mathematician, Marcus du Sautoy—a writer "able to engage general readers in the cerebral dramas of pure mathematics" (Booklist)—takes a unique look into the mathematical mind as he explores deep conjectures about symmetry and brings us face-to-face with the oddball mathematicians, both past and present, who have battled to understand symmetry's elusive qualities. "The author takes readers gently by the hand and leads them elegantly through some steep and rocky terrain as he explains the various kinds of symmetry and the objects they swirl around. Du Sautoy explains how this twirling world of geometric figures has strange but marvelous connections to number theory, and how the ultimate symmetrical object, nicknamed the Monster, is related to string theory. This book is also a memoir in which du Sautoy describes a mathematician's life and how one makes a discovery in these strange lands. He also blends in minibiographies of famous figures like Galois, who played significant roles in this field." —Publishers Weekly "Fascinating and absorbing." —The Economist "Impressively, he conveys the thrill of grasping the mathematics that lurk in the tile work of the Alhambra, or in palindromes, or in French mathematician Évariste Galois's discovery of the interactions between the symmetries in a group." —Kirkus Reviews

#### **Categories for Quantum Theory** Cambridge University Press

This is a description of the underlying principles of algebraic geometry, some of its important developments in the twentieth century, and some of the problems that occupy its practitioners today. It is intended for the working or the aspiring mathematician who is unfamiliar with algebraic geometry but wishes to gain an appreciation of its foundations and its goals with a minimum of prerequisites. Few algebraic prerequisites are presumed beyond a basic course in linear algebra.

#### **Higher Topos Theory** Courier Dover Publications

The book covers elementary aspects of category theory and topos theory. It has few mathematical prerequisites, and uses categorical methods throughout rather than beginning with set theoretic foundations. It works with key notions such as cartesian closedness, adjunctions, regular categories, and the internal logic

of a topos. Full statements and elementary proofs are given for the central theorems, including the fundamental theorem of toposes, the sheafification theorem, and the construction of Grothendieck toposes over any topos as base. Three chapters discuss applications of toposes in detail, namely to sets, to basic differential geometry, and to recursive analysis. - ;Introduction; PART I: CATEGORIES: Rudimentary structures in a category; Products, equalizers, and their duals; Groups; Sub-objects, pullbacks, and limits; Relations; Cartesian closed categories; Product operators and others; PART II: THE CATEGORY OF CATEGORIES: Functors and categories; Natural transformations; Adjunctions; Slice categories; Mathematical foundations; PART III: TOPOSES: Basics; The internal language; A soundness proof for topos logic; From the internal language to the topos; The fundamental theorem; External semantics; Natural number objects; Categories in a topos; Topologies; PART IV: SOME TOPOSES: Sets; Synthetic differential geometry; The effective topos; Relations in regular categories; Further reading; Bibliography; Index. -

#### **An Introduction to Category Theory** Cambridge University Press

This textbook explains the basic principles of categorical type theory and the techniques used to derive categorical semantics for specific type theories. It introduces the reader to ordered set theory, lattices and domains, and this material provides plenty of examples for an introduction to category theory, which covers categories, functors, natural transformations, the Yoneda lemma, cartesian closed categories, limits, adjunctions and indexed categories. Four kinds of formal system are considered in detail, namely algebraic, functional, polymorphic functional, and higher order polymorphic functional type theory. For each of these the categorical semantics are derived and results about the type systems are proved categorically. Issues of soundness and completeness are also considered. Aimed at advanced undergraduates and beginning graduates, this book will be of interest to theoretical computer scientists, logicians and mathematicians specializing in category theory.

#### **Handbook of Categorical Algebra: Volume 1, Basic Category Theory** IAP

This carefully written textbook provides an accessible introduction to the representation theory of algebras, including representations of quivers. The book starts with basic topics on algebras and modules, covering fundamental results such as the Jordan-Hölder theorem on composition series, the Artin-Wedderburn theorem on the structure of semisimple algebras and the Krull-Schmidt theorem on indecomposable modules. The authors then go on to study representations of quivers in detail, leading to a complete proof of Gabriel's celebrated theorem characterizing the representation type of quivers in terms of Dynkin diagrams. Requiring only introductory courses on linear algebra and groups, rings and fields, this textbook is aimed at undergraduate students. With numerous examples illustrating abstract concepts, and including more than 200 exercises (with solutions to about a third of them), the book provides an example-driven introduction suitable for self-study and use alongside lecture courses.