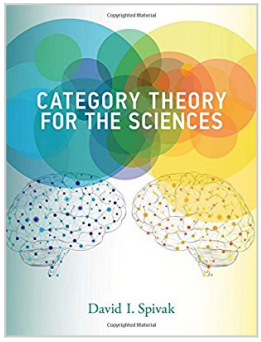

Category Theory for the Sciences (MIT Press)

By David I. Spivak

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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.

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- 496 pages

Editorial Review

Review
Spivak's book makes a good case that category theory... constitutes such a formalisation of common sense, that it can help structure the thinking of the working scientist (or indeed any human being involved in intellectual activity), and, above all: that it is both possible and enjoyable to learn the basic notions of category theory without a substantial background in pure mathematics. The book explains, in a fluent, straightforward and pedagogical style, how the basic principles of category theory are concepts we already know without admitting it, shows how the theory unifies this implicit knowledge, and stresses the advantage we can take from recognising and mastering the unifying concepts. --Joachim Kock, SIAM Book reviews

This is the first, and so far the only, book to make category theory accessible to non-mathematicians. Starting from the interesting new notion of 'ontological logs' (ologs), the basic concepts of category theory are then introduced where and when needed, inspired by applications.

(Piet Hut, Professor of Astrophysics and Head of the Program in Interdisciplinary Studies, Institute for Advanced Study, Princeton)

Category theory was invented in the middle of the last century with the goal of better connecting algebra with topology. It has since produced a network of connections between all branches of mathematics as well as between mathematics, sciences, and engineering. This book introduces basic categorical ideas from a variety of simple examples. The author writes in clear, direct, and imaginative language. His ologs make me believe in universal knowledge, from physics and chemistry to biology and computer sciences. Abstractions are made concrete and useful. You will travel from databases to the category of categories and beyond.

(André Joyal, Fellow of the Royal Society of Canada)

Category theory has long been recognized as a powerful tool for unifying different branches of pure mathematics, but its potential for applications has barely begun to be tapped. Twenty years from now there will be lots of books on applied category theory, but their authors will all have read Spivak.

(John Baez, Professor of Mathematics, University of California, Riverside)

This book is the first in its field to demonstrate the power of category theory as a tool for applied scientists and engineers. A fantastic introduction to the theory as well as all the information needed to make it directly usable by non-mathematicians. A remarkable piece of work.

(Stephen Molloy, Head of Accelerator Engineering for the European Spallation Source, and Adjunct Lecturer in Accelerator Physics, University of Lund, Sweden)

This is a great book not only for the scientist who wants to learn Category theory, but for the mathematician as well.

(Nick Scoville *MAA Reviews*)

From the Author
This book is designed to be read by scientists and other people. It has very few mathematical prerequisites; for example, it doesn't require calculus, linear algebra, or statistics. It starts by reintroducing the basics: What is a set? What is a function between sets?

That said, having a teacher or resident expert will be very helpful. Category theory is a "paradigm shift"---it's a new way of looking at things. If you progress past the first few chapters, you'll see that it's a language for having very big thoughts and making unusually deep analogies.

To make real progress in this book (unless you're used to reading university-level math books on your own) it will be useful to periodically check your understanding with someone who has some training in the subject. Seek out a math grad student or even a Haskell expert to help you. A growing number of people are learning basic category theory.

In order to really learn this material, a formal teacher or a professor would be best. Encourage your local university math department to offer a course in Category Theory for the Sciences. I can recommend this in good faith, because I went to special efforts to make this book available for free online. An old version of the book exists on the math arXiv, and a new MIT Press-edited version exists in HTML form on their website (see URLs below). That said, the print version, available here on Amazon and elsewhere, is much easier to read, if you want to get serious and you can afford it.

This book contains about 300 exercises and solutions. For those who wish to teach a course in the subject, there are 193 additional exercises and solutions behind a professors-only wall on the MIT Press website (see URL below). You simply have to request access.

To everyone: I hope you enjoy the book, and get a lot out of it!

Old version: arxiv.org/abs/1302.6946
HTML version: mitpress.mit.edu/books/category-theory-sciences

About the Author

David I. Spivak is a Research Scientist in the Department of Mathematics at MIT.

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Maria Trussell:

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