

# CUT ELIMINATION IN CATEGORIES

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This book was published by Elsevier Borel Dordrecht (in the series *Tracts in Logic*, vol. 5) in 1993. The sketches and corrigenda (in particular in §2.4-10.5, 11.1, 11.4 and in the references) are here incorporated. The pagination differs from the published version.

# Cut Elimination In Categories

**Dov M. Gabbay, John Hayden  
Woods, John Woods, Akihiro Kanamori**

## Cut Elimination In Categories:

**Cut Elimination in Categories** K. Dosen, 2013-04-18 Proof theory and category theory were first drawn together by Lambek some 30 years ago but until now the most fundamental notions of category theory as opposed to their embodiments in logic have not been explained systematically in terms of proof theory Here it is shown that these notions in particular the notion of adjunction can be formulated in such a way as to be characterised by composition elimination Among the benefits of these composition free formulations are syntactical and simple model theoretical geometrical decision procedures for the commuting of diagrams of arrows Composition elimination in the form of Gentzen's cut elimination takes in categories and techniques inspired by Gentzen are shown to work even better in a purely categorical context than in logic An acquaintance with the basic ideas of general proof theory is relied on only for the sake of motivation however and the treatment of matters related to categories is also in general self contained Besides familiar topics presented in a novel simple way the monograph also contains new results It can be used as an introductory text in categorical proof theory     *Coherence in Categories* Saunders Mac Lane, 2006-11-15     **Applications of Categories in Computer Science** M. P. Fourman, P. T. Johnstone, A. M. Pitts, 1992-06-26 Category theory and related topics of mathematics have been increasingly applied to computer science in recent years This book contains selected papers from the London Mathematical Society Symposium on the subject which was held at the University of Durham Participants at the conference were leading computer scientists and mathematicians working in the area and this volume reflects the excitement and importance of the meeting All the papers have been refereed and represent some of the most important and current ideas Hence this book will be essential to mathematicians and computer scientists working in the applications of category theory     **Categories in Computer Science and Logic** John Walker Gray, 1989 Presents the proceedings of AMS IMS SIAM Summer Research Conference on Categories in Computer Science and Logic that was held at the University of Colorado in Boulder This book discusses the use of category theory in formalizing aspects of computer programming and program design     *New Structures for Physics* Bob Coecke, 2011 This volume provides a series of tutorials on mathematical structures which recently have gained prominence in physics ranging from quantum foundations via quantum information to quantum gravity These include the theory of monoidal categories and corresponding graphical calculi Girard's linear logic Scott domains lambda calculus and corresponding logics for typing topos theory and more general process structures Most of these structures are very prominent in computer science the chapters here are tailored towards an audience of physicists     *Categories and Types in Logic, Language, and Physics* Claudia Casadio, Bob Coecke, Michael Moortgat, Philip Scott, 2014-04-03 For more than 60 years Jim Lambek has been a profoundly inspirational mathematician with groundbreaking contributions to algebra category theory linguistics theoretical physics logic and proof theory This Festschrift was put together on the occasion of his 90th birthday The papers in it give a good picture of the multiple research areas where the impact of Jim Lambek's work can be felt The volume includes

contributions by prominent researchers and by their students showing how Jim Lambek's ideas keep inspiring upcoming generations of scholars

**Proof-net Categories** Kosta Dosen, Zoran Petrić, 2007 Advances in Proof-Theoretic Semantics Thomas Piecha, Peter Schroeder-Heister, 2015-10-24 This volume is the first ever collection devoted to the field of proof theoretic semantics Contributions address topics including the systematics of introduction and elimination rules and proofs of normalization the categorial characterization of deductions the relation between Heyting's and Gentzen's approaches to meaning knowability paradoxes proof theoretic foundations of set theory Dummett's justification of logical laws Kreisel's theory of constructions paradoxical reasoning and the defence of model theory The field of proof theoretic semantics has existed for almost 50 years but the term itself was proposed by Schroeder Heister in the 1980s Proof theoretic semantics explains the meaning of linguistic expressions in general and of logical constants in particular in terms of the notion of proof This volume emerges from presentations at the Second International Conference on Proof Theoretic Semantics in Tübingen in 2013 where contributing authors were asked to provide a self contained description and analysis of a significant research question in this area The contributions are representative of the field and should be of interest to logicians philosophers and mathematicians alike

**Category Neutrality** Neil Whitman, 2004-08 It has been claimed that category neutrality where a word or a phrase is used simultaneously with more than one syntactic category does not exist This work shows that it does exist in English This work not only challenges the current thinking but also raises foundational questions about the nature of ambiguity

**Categories for the Working Mathematician** Saunders Mac Lane, 2013-04-17 Categories for the Working Mathematician provides 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 The book 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 characterized 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 two new chapters on topics of active interest One is nonsymmetric monoidal categories and braided monoidal categories and the coherence theorems for them The second describes 2 categories and the higher dimensional categories which have recently come into prominence The bibliography has also been expanded to cover some of the many other recent advances concerning categories

**Categories for the Working Mathematician** Saunders MacLane, 2013-11-11 Category Theory has developed rapidly This book aims to present those ideas and methods which can now be effectively used by Mathematicians working in a variety of other fields of Mathematical research This occurs at several levels On the first level categories provide a convenient conceptual language

based on the notions of category functor natural transformation contravariance and functor category These notions are presented with appropriate examples in Chapters I and II Next comes the fundamental idea of an adjoint pair of functors This appears in many substantially equivalent forms That of universal construction that of direct and inverse limit and that of pairs of functors with a natural isomorphism between corresponding sets of arrows All these forms with their interrelations are examined in Chapters III to V The slogan is Adjoint functors arise everywhere Alternatively the fundamental notion of category theory is that of a monoid a set with a binary operation of multiplication which is associative and which has a unit a category itself can be regarded as a sort of generalized monoid Chapters VI and VII explore this notion and its generalizations Its close connection to pairs of adjoint functors illuminates the ideas of universal algebra and culminates in Beck's theorem characterizing categories of algebras on the other hand categories with a monoidal structure given by a tensor product lead inter alia to the study of more convenient categories of topological spaces

*Proof Theory in Computer Science* Reinhard Kahle, Peter Schroeder-Heister, Robert Stärk, 2003-06-30 Proof theory has long been established as a basic discipline of mathematical logic It has recently become increasingly relevant to computer science The deductive apparatus provided by proof theory has proved useful for metatheoretical purposes as well as for practical applications Thus it seemed to us most natural to bring researchers together to assess both the role proof theory already plays in computer science and the role it might play in the future The form of a Dagstuhl seminar is most suitable for purposes like this as Schlo Dagstuhl provides a very convenient and stimulating environment to discuss new ideas and developments To accompany the conference with a proceedings volume appeared to us equally appropriate Such a volume not only gives basic results of the subject and makes them available to a broader audience but also signals to the scientific community that Proof Theory in Computer Science PTCS is a major research branch within the wider field of logic in computer science

**Category Theory** Zoran Majkic, 2023-03-06 This book analyzes the generation of the arrow categories of a given category which is a foundational and distinguishable Category Theory phenomena in analogy to the foundational role of sets in the traditional set-based Mathematics for definition of natural numbers as well This inductive transformation of a category into the infinite hierarchy of the arrow categories is extended to the functors and natural transformations The author considers invariant categorical properties the symmetries under such inductive transformations The book focuses in particular on Global symmetry invariance of adjunctions and Internal symmetries between arrows and objects in a category in analogy to Field Theories like Quantum Mechanics and General Relativity The second part of the book is dedicated to more advanced applications of Internal symmetry to Computer Science for Intuitionistic Logic Untyped Lambda Calculus with Fixpoint Operators Labeled Transition Systems in Process Algebras and Modal logics as well as Data Integration Theory

**Category Theory, Homology Theory and Their Applications. Proceedings of the Conference Held at the Seattle Research Center of the Battelle Memorial Institute, June 24 - July 19, 1968** P. J. Hilton, 2006-11-14

**Algebra of Proofs** M. E.

Szabo, 2016-06-03 *Algebra of Proofs* deals with algebraic properties of the proof theory of intuitionist first order logic in a categorical setting. The presentation is based on the confluence of ideas and techniques from proof theory, category theory and combinatory logic. The conceptual basis for the text is the Lindenbaum-Tarski algebras of formulas taken as categories. The formal proofs of the associated deductive systems determine structured categories as their canonical algebras which are of the same type as the Lindenbaum-Tarski algebras of the formulas of underlying languages. Gentzen's theorem which asserts that provable formulas code their own proofs links the algebras of formulas and the corresponding algebras of formal proofs. The book utilizes the Gentzen's theorem and the reducibility relations with the Church-Rosser property as syntactic tools. The text explains two main types of theories with varying linguistic complexity and deductive strength: the monoidal type and the Cartesian type. It also shows that quantifiers fit smoothly into the calculus of adjoints and describe the topos-theoretical setting in which the proof theory of intuitionist first order logic possesses a natural semantics. The text can benefit mathematicians, students or professors of algebra and advanced mathematics.

### **Category Theory and Computer Science**

David H. Pitt, Pierre-Louis Curien, Samson Abramsky, Andrew Pitts, Axel Poigne, David E. Rydeheard, 1991-08-21. The papers in this volume were presented at the fourth biennial Summer Conference on Category Theory and Computer Science held in Paris, September 3-6, 1991. Category theory continues to be an important tool in foundational studies in computer science. It has been widely applied by logicians to get concise interpretations of many logical concepts. Links between logic and computer science have been developed now for over twenty years, notably via the Curry-Howard isomorphism which identifies programs with proofs and types with propositions. The triangle category theory logic programming presents a rich world of interconnections. Topics covered in this volume include the following: Type theory, stratification of types and propositions can be discussed in a categorical setting. Domain theory, synthetic domain theory, develops domain theory internally in the constructive universe of the effective topos. Linear logic, the reconstruction of logic based on propositions as resources leads to alternatives to traditional syntaxes. The proceedings of the previous three category theory conferences appear as Lecture Notes in Computer Science Volumes 240, 283 and 389.

### **The Blind Spot**

Jean-Yves Girard, 2011. These lectures on logic, more specifically proof theory, are basically intended for postgraduate students and researchers in logic. The question at stake is the nature of mathematical knowledge and the difference between a question and an answer, i.e. the implicit and the explicit. The problem is delicate mathematically and philosophically as well: the relation between a question and its answer is a sort of equality where one side is more equal than the other one thus discovers essentialist blind spots. Starting with Gödel's paradox (1931) so to speak the incompleteness of answers with respect to questions, the book proceeds with paradigms inherited from Gentzen's cut elimination (1935). Various settings are studied: sequent calculus, natural deduction, lambda calculus, category theoretic composition up to geometry of interaction. GoI, all devoted to explicitation which eventually amounts to inverting an operator in a von Neumann algebra. Mathematical language is usually described as referring to a preexisting

reality Logical operations can be given an alternative procedural meaning typically the operators involved in GoI are invertible not because they are constructed according to the book but because logical rules are those ensuring invertibility Similarly the durability of truth should not be taken for granted one should distinguish between imperfect perennial and perfect modes The procedural explanation of the infinite thus identifies it with the unfinished i e the perennial But is perennality perennial This questioning yields a possible logical explanation for algorithmic complexity This highly original course on logic by one of the world's leading proof theorists challenges mathematicians computer scientists physicists and philosophers to rethink their views and concepts on the nature of mathematical knowledge in an exceptionally profound way

*A Century of Mathematics in America* Peter L. Duren, Richard Askey, Uta C. Merzbach, Harold M. Edwards, 1988 Part of the History of Mathematics series this book presents a variety of perspectives on the political social and mathematical forces that have shaped the American mathematical community *Towards Higher Categories* John C. Baez, J. Peter

May, 2009-09-23 This IMA Volume in Mathematics and its Applications TOWARDS HIGHER CATEGORIES contains expository and research papers based on a highly successful IMA Summer Program on n Categories Foundations and Applications We are grateful to all the participants for making this occasion a very productive and stimulating one We would like to thank John C Baez Department of Mathematics University of California Riverside and J Peter May Department of Mathematics University of Chicago for their superb role as summer program organizers and editors of this volume We take this opportunity to thank the National Science Foundation for its support of the IMA Series Editors Fadil Santosa Director of the IMA Markus Keel Deputy Director of the IMA v PREFACE DEDICATED TO MAX KELLY JUNE 5 1930 TO JANUARY 26 2007 This is not a proceedings of the 2004 conference n Categories Foundations and Applications that we organized and ran at the IMA during the two weeks June 7-18 2004 We thank all the participants for helping make that a vibrant and inspiring occasion We also thank the IMA staff for a magnificent job There has been a great deal of work in higher category theory since then but we still feel that it is not yet time to offer a volume devoted to the main topic of the conference **Sets and**

**Extensions in the Twentieth Century** Dov M. Gabbay, John Hayden Woods, John Woods, Akihiro Kanamori, 2004 In designing the Handbook of the History of Logic the Editors have taken the view that the history of logic holds more than an antiquarian interest and that a knowledge of logic's rich and sophisticated development is in various respects relevant to the research programmes of the present day Ancient logic is no exception The present volume attests to the distant origins of some of modern logic's most important features such as can be found in the claim by the authors of the chapter on Aristotle's early logic that from its infancy the theory of the syllogism is an example of an intuitionistic non monotonic relevantly paraconsistent logic Similarly in addition to its comparative earliness what is striking about the best of the Megarian and Stoic traditions is their sophistication and originality

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