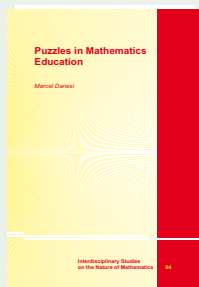


Interdisciplinary Studies on the Nature of Mathematics

Puzzles in Mathematics Education

Marcel Danesi
University of Toronto



Puzzles emerge at the dawn of history, revealing something intrinsic about human thinking. As such, they have allowed us to play with reality in clever and ingenious forms, from riddles to mathematical games such as Archimedes' loculus. Significantly, puzzles have often been the source of new ideas in mathematics, leading to the establishment of new fields and branches. Given their exploratory nature, it is not surprising to find that puzzles were at the core of mathematics education in antiquity. An early math textbook, called the Ahmes Papyrus (1650 BCE), is a case-in-point. It contains challenging puzzles that were apparently intended for the education of Egyptian youth. Similar texts exist across the ancient world. Clearly, puzzles were perceived as intrinsic to mathematics and how it is learned. Today, it is rare to find entire courses and curricula that revolve around puzzles in a similar way. Typically, puzzles are used as ancillary devices in the

production of learning materials and in curricula, not as the core of math pedagogy. This book argues that putting puzzles at the center of math curricula, as was the case in antiquity, will enhance learning outcomes in all types of students. The book describes the classic math puzzles, deconstructing their psychological features, so that their pedagogical value can be examined concretely.

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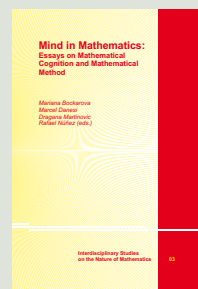
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Mind in Mathematics: Essays on Mathematical Cognition and Mathematical Method

Mariana Bockarova (Harvard University)
Marcel Danesi (University of Toronto)
Dragana Martinovic (University of Windsor)
Rafael Núñez (University of California, San Diego) (eds.)



This volume brings together key essays by mathematicians, cognitive scientists, neuroscientists, semioticians, and educators on the nature of mathematical thought and how it unfolds in relation to language and other codes. Topics such as the role of analogy and metaphor, as well as inferential (abductive) thinking, are examined through several interdisciplinary lenses. The goal of this volume is to establish a

"hermeneutic" field of study in mathematical cognition that aims to understand how mathematics dovetails with other human faculties.

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LINCOM Textbooks in Mathematics

A primer of Hilbert space

Claudi Meneghin

MIUR (Ministero dell'Istruzione Università e Ricerca)

This book deals with the very basic theory of Hilbert space. Chapter 1 deals with the fundamental theory of vector spaces. The notion of a vector space is recalled, together with related techniques. Key definitions and theorems concerning vector spaces in general and linear independence are then reviewed.

In chapter 2 the notions of an inner product, normed space and metric space are examined, together with their mutual relationships.

Finally, in chapter 3 the very basic tools in the theory of Hilbert space are studied, introducing the natural generalisation of the customary vector space notions to the infinite dimensional framework. In particular, the matter of expanding a vector in terms of a (not necessarily finite) orthogonal basis is introduced. Several examples, problems and exercises are proposed.

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Chapter 1. Vector spaces: basic definitions and properties

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ISBN 9783862884278. LINCOM Textbooks in Mathematics 01.110pp. USD 37.00 / EUR 30.80 / GBP 27.80. 2013.

Semiotic and Cognitive Science Essays on the Nature of Mathematics

Mariana Bockarova (Harvard University), Marcel Danesi (University of Toronto), Rafael Núñez (University of California, San Diego) (eds.)

This volume brings together key studies in an emerging interdisciplinary field aiming to study mathematical cognition written by internationally-renowned scholars in fields ranging from mathematical theory to cognitive science and semiotics. The thematic thread that runs through all these studies is that the comprehension and learning of mathematical concepts involves complex neural and cognitive process, such as blending, metaphor, semiosis, and various forms of language. Each article presents its particular perspective in a clear way so that it can be read by scholars in any of the disciplines covered, and it presents ideas and empirical findings that point to the need for a new interdisciplinary mode of investigating mathematical cognition and its relation to other cognitive processes.

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ISBN 9783862883325 (Hardbound). **Interdisciplinary Studies on the Nature of Mathematics 01**. USD 158.20 / EUR 131.80 / GBP 118.60. 240pp. 2012.

Discovery in Mathematics: An Interdisciplinary Perspective

Marcel Danesi

Department of Anthropology, University of Toronto, and Fields Institute for Research in Mathematical Sciences

This book examines the nature of discovery of mathematics and how it is connected to notation, representation, and language. Using insights from modeling systems theory in semiotics and blending theory in cognitive science, it puts forward the idea that discovery is interconnected with representation, with one model providing insights into deeper structures hidden or implicit in the models themselves. It will look in particular at how diagrammatic reasoning undergirds how mathematicians think and how this, in itself, is a source of further ideas and conceptualizations in the field, leading to new models, new theories, branches, and so on.

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ISBN 9783862883974 (Hardcover). **Interdisciplinary Studies on the Nature of Mathematics 02**. (Series editor: Marcel Danesi, University of Toronto). 186pp. USD 142.60 / EUR 118.80 / GBP 106.20. 2013

Mathematical and Computational Linguistics

H. Mark Hubey

Montclair State University

As Lass (1980) has remarked, "system" is something talked about constantly in linguistics but never beyond paying just lip-service to the concept. This book shows how linguistics constitutes a "system". Linguists (except those who study Formal Language Theory) are confronted with a dilemma. What they study is partially based on physics and is in many respects mathematical; yet the mathematics books are divorced from linguistics and linguistics books are divorced from mathematics and physics. There are no books that teach

mathematics for linguists or linguistics with mathematics. This book goes a long way toward accomplishing the integration of mathematics, physics and linguistics into a whole, in other words "a system", just like those that are studied by others in the quantitative disciplines such as physics, engineering, computer science or economics.

The methods of mathematics which are used in the books to elucidate system concepts and others that are needed in linguistics includes boolean algebra, differential equations, and fuzzy logic.

Furthermore it also explains in an intuitive manner, those concepts are not only from mathematics but also from the underlying physics and engineering up to and including acoustic theory of speech, speech recognition, and even nonlinearity / catastrophe theory and quantity of phonemic systems.

All the mathematics needed to form the mathematical foundations of linguistics is illustrated with examples from linguistics and thus may be thought of as "theories", those that should replace the standard literary linguistics tradition in the same way that literary economics is no longer the de facto standard. Physical/acoustic theory of speech is blended naturally into the phonological and phonetic standard, and the standard works are used as springboards to the development of vector space concepts that are necessary for comprehension of new works in speech synthesis and speech recognition. It is rather easy then to show how seemingly unrelated topics such as sonority scales, child language development, and various linguistics processes such as assimilation, metathesis, fortition/lenition can be seen to be a part of the greater whole. Historical processes are also treated in terms of sound change and also in terms of the most basic ideas which are needed for a thorough understanding of the problems such as multiple scale phenomena, distance and similarity, probability theory, and stochastic processes. A book of this length cannot possibly discuss all of the mathematics necessary in detail, however, there is sufficient material to motivate the topics, and furthermore to point in the direction of further study.

ISBN 9783895866395. **LINCOM Handbooks in Linguistics 09**. 450pp. USD 148.00 / EUR 123.30 / GBP 111.00. 1999.

Noam Chomsky on Language and Cognition

A. Sumru Özsoy & Mine Nakipoğlu (eds.)
Boğaziçi University

This book presents a discussion by Noam Chomsky of some of the much controversial issues raised within the scientific field of linguistics since the inception of generative grammar in 1957. Based on the text of the talk given by Noam Chomsky at Boğaziçi University, Istanbul, in 2002, the book presents Prof. Chomsky's views on the philosophical bases and the historical development of the field of biolinguistics in the course of which he focuses on issues such as cognition, linguistics as a science, how the field developed, its nature and how it fits into the other domains of science.

The questions raised within the question-comment session lead Prof. Chomsky to expand his views on the nature of Universal Grammar, in particular on the philosophical underpinnings of the program which disfavors the view that languages are radically different. Prof. Chomsky also answers questions on the implications of theory-internal assumptions such as the determinants of phasehood in syntax, the nature of the innateness hypothesis, the nature-nurture debate within language acquisition, in particular the validity of the poverty of the stimulus arguments, the nature of the semantic component and the representation of the mental lexicon and the political implications of his Universal Grammar position on his activist stance.

ISBN 9783929075618. **Linguistics Edition 73**. 52pp. USD 53.20 / EUR 44.40 / GBP 40.00. 2009.

LINCOM Studies in Neurobiology

A Neurobiological Theory and Method of Language Acquisition

Daniel S. Janik

Intercultural Communications College, Honolulu

This monograph is NOT about teaching - it's about EFFECTIVE LEARNING from a perspective that leads to an entirely new form of learning and language acquisition involving transformational discovery, mentorship and interpretation.

Its roots are as old as Socrates. Linguists, biologists, anatomists, physiologists, psychologists, sociologists and physicians in the tradition of the "German School" of learning have contributed over the centuries to what is now nothing less than a revolution in learning, and the "business of teaching."

In this seminal work, the author has drawn from contemporary clinical and experimental data beginning with effective traumatic learning to develop a Neurobiological theory of learning, including methodology and tenets. When applied in a traditional language classroom setting, the results have been nothing short of astounding.

With its focus on language acquisition and learning, this monograph is a treasure-trove of new information for educators, linguists, "teachers," tutors, psychologists, physicians and researchers interested in transforming a field that has remained in the "dark ages" for too long.

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ISBN 9783895867637. LINCOM Studies in Neurobiology 01. 300pp.USD 123.80 / EUR 103.20 / GBP 92.80. 2004.

Language and cognition: meaning across contexts

Mikołaj Deckert and Iwona Witzczak-Plisiecka (eds.)
University of Lodz

Using the principles and methods of cognitive linguistics, pragmatics as well as corpus linguistics, this volume offers insights into how language structure and contextualised language use condition the meaning-making process. A total of ten contributors draw from English, Greek, German, Hungarian, Latin, Polish, Russian and Ukrainian to examine different types of

linguistic evidence ranging from academic discourse, to literature, church language as well as media language. While the papers employ a choice of analytic constructs and research methodologies, they share the central objective of uncovering, systematically describing and explaining some of the patterns of language-prompted meaning construction and communication, both intralingually and in a contrastive perspective.

Contents

Mikołaj Deckert and Iwona Witzczak-Plisiecka : *Language and cognition: meaning across contexts*

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ISBN 9783862887019 (Hardbound). LINCOM Studies in Pragmatics 28. USD 146.40 / EUR 122.00 / GBP 109.80. 150pp. 2016.

Topology and Cognition

What Image-schemas Reveal about the Metaphorical Language of Emotions.

M. Sandra Peña Cervel

National University of Distance Education (Madrid)

This book is meant to overcome some of the problems and controversial issues which were raised by the traditional treatment of the metaphorical phenomenon within the framework of Cognitive Linguistics. Additionally, it has been my intention to counteract the unwelcome tendency to view emotions as elusive and chaotic entities which display no coherent structure. Criticism of previous accounts has pointed to an inability to incorporate the experiential grounding into a sound theory of metaphor. The existence of image-schemas and their great potential for lying at the base of a great number of metaphorical expressions is attested in the English language and proves that the experiential component plays a very important role in the conceptualization of a seemingly abstract domain: emotions.

Along these lines, the way metaphorical expressions which incorporate image-schematic structure are constructed and processed is shown. Another focus on attention is on the way in which mental spaces combine as guided by the basic conceptual structure provided by image-schemas to prepare the source of some metaphors for the mapping process. In relation to this, the notions of interaction and schematic enrichment have proved useful and have allowed us to determine the principles of focalization of meaning constituents within their frames of reference. This discussion also makes it possible to establish hierarchies of prominence inside image-schemas depending on their intrinsic nature, i. e. on whether they act temporarily or not as subsidiary to other schemas.

This book is not only addressed to the researcher interested in the study of metaphor from the point of view of Cognitive Linguistics but also to any university student who wants to revise the main notions of this theory as well as a brief history of metaphor. The contents of this book have been organized into eight chapters. Chapter 1 constitutes the introduction to the work. In chapter 2 the different approaches to metaphor undergo critical revision mainly from a cognitive standpoint. This chapter provides the reader with a brief overview of the study of metaphor throughout history, from the classical period, through the sixteenth, seventeenth, eighteenth centuries, and the Romantic period, down to the twentieth century. All these approaches fall under the general rubric of objectivism and rely on the

assumption that metaphor is a linguistic device used in order to enhance poetic language.

On the other hand, it is argued that the cognitive theory of metaphor assigns metaphor a central role in language and thought. Within this framework it is also postulated that metaphor does in fact account for a large portion of what we both know and think, not to mention what we even feel and do in our daily lives. Additionally, an overview of experientialism as opposed to objectivism is given and special emphasis is placed on metaphor as a kind of idealized cognitive model. In chapter 3, another structuring principle, image-schemas, is dealt with by offering a lengthy description of its characteristics and nature. An alternative proposal for a taxonomy of schemas is made after pointing to the main inadequacies of existing hierarchies of such constructs. By specifying the general theoretical postulates that serve as our point of departure, the ground is prepared for the analysis of the corpus and the presentation of the results derived from it in chapters 4, 5, 6, and 7. Finally, chapter 8 offers some concluding remarks.

ISBN 9783895863097. LINCOM Studies in Cognitive Linguistics 01. 320pp. USD 127.60 / EUR 106.30 / GBP 95.60. 2003.

Language-Cognition Interface: State of the Art

Ramesh Kumar Mishra & Narayanan Srinivasan (eds.)

Centre for Behavioural and Cognitive Science (CBCS), University of Allahabad

Significant theoretical developments have taken place in language-cognition research in the last few decades. The collected chapters in this book provide extensive coverage of important areas of this research domain including bilingualism, sentence processing, and embodied cognition. The chapters written by experts provide the reader the most up to date discussion about issues and controversies while providing theoretical and empirical knowledge about these themes. In spite of the wide range of topics covered, there has been an attempt to make the collection thematically coherent providing the state of the art in language-cognition research.

The chapters have been written for both researchers as well as graduate students interested in basic issues in language-cognition research and their relevance for larger issues on language and cognition. The other most significant aspect of this volume is the emphasis on multi-disciplinary approaches and cross-cultural emphasis. The volume offers excellent material to researchers who wish to compare studies across languages and cultural boundaries. The basic purpose of the volume then is to present substantially the main arguments and research themes as well as methodological issues in the broad area of language-cognition research to a wider audience in linguistics, psycholinguistics, psychology, neurosciences and cognitive science.

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Sonali Nag: *The akshara languages: What do they tell us about children's literacy learning?*

ISBN 9783862880010 (Hardbound). **LINCOM Studies in Theoretical Linguistics 44**. 380 pp. USD 203.20 / EUR 169.30 / GBP 152.40. 2010.

Verbal Communication Pragmatics, Relevance and Cognition

Xosé Rosales Sequeiros
University of Liverpool

This book explores current pragmatic theory, focussing on a number of key aspects within utterance interpretation, communication and cognition. It argues against traditional approaches to the study of pragmatic interpretation, such as the Gricean framework, and discusses an alternative account based on the notion of relevance, which integrates the role of context and cognition within verbal communication.

This alternative view shows that it is possible to provide a unified account of pragmatics by taking into account two fundamental aspects of human cognition: processing effort and cognitive effects. The interaction between these aspects and communicative cognition provides the basis for a comprehensive account of utterance interpretation, which resolves many of the problems encountered by earlier approaches.

In applying and developing these pragmatic concepts, a number of areas are covered within verbal communication. Firstly, the current framework is considered as a general approach to pragmatics. Secondly, the distinction between explicit and implicit meaning is applied to a range of constructions. Thirdly, there is a discussion on the role of pragmatics in disambiguation processes. Finally, the new approach is applied to irony and metaphor, including a discussion on the new research area of lexical pragmatics.

ISBN 9783862885879 (Hardcover). **LINCOM Studies in Pragmatics 26**. 270pp. USD 166.60 / EUR 138.80 / GBP 125.00. 2014.

The Neural Basis of Language

Ángel López-García
University of Valencia

The continuity (distributed structure) and the discontinuity (modular structure) are not the exclusive property of neural webs that affect wide areas of the brain, but their possibility is implied in the microscopic base within themselves. This situation is found in all types of psychic activity: emotional, rational and linguistic, although in a different way in each of them. Language maximizes the coexistence of both types of nervous processing maintaining them in equilibrium from the first moment. A theory of language which is capable of assuming the two

perspectives is needed, since it is the only one that is neurologically justified. In this book it is proposed that said theory be constructed on Gestaltic principles; this is because Gestaltic principles formally adjust to Topological rules, which allow us to, at the same time, be informed about the spatial reception of the world, specific to the dominated hemisphere, and its correlative verbalization through some form of natural language, which is specific to the dominant hemisphere.

ISBN 9783895864056. **LINCOM Studies in Neurolinguistics 03**. 60 illustrations. 134pp. USD 101.00 / EUR 84.20 / GBP 75.80. 2007.

Petri Net Approaches for Modelling and Validation

Wil van der Aalst, José-Manuel Colom, Fabrice Kordon, Gabriela Kotsis & Daniel Moldt

The successful realization of complex systems of interacting and reactive software and hardware components relies heavily on the use of a precise language at different stages of the development process. Petri nets are becoming increasingly popular in this area, as they provide a uniform language supporting the tasks of modelling, verification, and validation. Their popularity is due to the fact that fundamental aspects of causality, concurrency, and choice are captured by Petri nets in a natural and mathematically precise way without compromising readability.

Several methods, techniques, tools, and algorithms have been developed to ease the practical work and support the basic ideas behind the usage of Petri nets in the area of system engineering. However, this does not mean that complete and ready to use systems and approaches are available or even established. Therefore, a general understanding of the potentials of Petri nets in the context of system engineering needs to be provided and distributed.

The workshop "Petri Nets in System Engineering" (PNSE'97) was held at the Department of Computer Science, University of Hamburg on September 25-26, 1997. It brought together experts from the communities of Petri nets and system engineering both from industry and academia to exchange the newest results and experiences. The workshop was organized by the members of the European community project MATCH (Modelling and Analysis of Time Constrained and Hierarchical Systems). Project partners include the universities of Eindhoven, Genova, Hamburg, Paris, Turin, Vienna, and Zaragoza. This post-workshop book puts together some papers presented at the workshop which were rewritten and then selected after a second reviewing process. The selected approaches cover modelling, verification, and validation. They provide an insight into new ideas of modelling and validation with modules or objects and a comparison of event- and state-based modelling. Some contributions explain verification techniques based on state spaces and temporal logic. This allows event- and state-based specification and verification. Furthermore, the analysis of systems by structural techniques is covered as well as feasibility of using Petri nets and related tools for the analysis of workflows. Altogether the papers reflect current and relevant research and work on Petri nets in system engineering.

Contents: W.M.P. van der Aalst: Putting Petri Nets to Work in the Workflow Arena. S. Christensen, L.M. Kristensen: State Space Analysis of Hierarchical Coloured Petri Nets. O. Fricke: Data Abstraction in Petri Nets as Modular Structuring Concept. F. Garcia-Valles, J.M. Colom: Structural Analysis of Signal Transition Graphs based on Linear Algebra Techniques. J.B. Jorgensen, L.M. Kristensen: Verification of Coloured Petri Nets Using State Spaces with Equivalence Classes. E. Kindler, T. Vesper: ESTL: Some Proof Techniques. R. Mackenthun, M. Voorhoeve: Modelling and Verification with Petri Nets. Ch. Maier, D. Moldt: Dynamic Structure and Behaviour of Coloured Petri Nets Supporting Object-Oriented Modelling.

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Konturbasierte Bildbewegung und Objektverfolgung in Echtzeit-Anwendungen

Axel Techmer

Die Verbesserung von Sicherheit, Komfort und Verkehrsfluss bedeutet eine wesentliche Herausforderung für den künftigen Straßenverkehr. Die Auswertung von Kamerabildern stellt hierfür eine Schlüsseltechnologie dar. Das Erkennen der Fahrspur sowie anderer Verkehrsteilnehmer aus einer Videosequenz erlaubt eine automatische Überwachung des toten Winkels, die Unterstützung des Fahrers beim Überholvorgang, die Warnung vor einem unbeabsichtigten Verlassen der Fahrspur ("Einschlagwarner"), das automatische Einhalten von Sicherheitsabständen usw. Neben diesen so genannten Fahrerassistenzsystemen stellt auch das automatische Erfassen von Verkehrsdaten eine wichtige Aufgabe im modernen Straßenverkehr dar.

Die Auswertung von Videosequenzen, aufgenommen in natürlicher Umgebung, liefert aber häufig noch unbefriedigende Ergebnisse. Dies gilt vor allem, wenn die Robustheit der Auswertung mit dem menschlichen Sehsystem verglichen wird, die Verarbeitung in Echtzeit erfolgt und zudem der Wunsch nach preiswerten Systemen die Rechenleistung beschränkt. Für das menschliche Sehsystem bildet die in den Szenen enthaltene Bewegung eine Basisinformation für das Verstehen von Bildern. Bewegung ist auch eine dominierende Größe in Verkehrssituationen. Die Bestimmung der Bewegung aus Bildfolgen erwies sich in früheren Ansätzen als problematisch und rechenaufwändig.

In der vorliegenden Arbeit wird ein neuer Ansatz zur Bestimmung der Bildbewegung und Objektverfolgung entwickelt, der es ermöglicht, Bewegung als Basisinformation in Echtzeit-Anwendungen zu nutzen. Diese neuartige Bewegungsbestimmung wird beispielhaft an zwei Anwendungen, einem Überholwarner auf Autobahnen und eine visuelle Verkehrserfassung, erprobt.

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Formaler Entwurf effizienter Authentisierungsprotokolle mit Schlüsselabsprache

Gunnar Jacobson

The author presents a new, original method for the formal requirements definition and the design of authentication and key-agreement protocols and demonstrates its usage as a design-tool for such protocols. The exemplary formal design of Kerberos demonstrates the applicability and reliability of the method. The author then classifies cryptosystems and protocol runs and provides a generic design approach, which is on an idealised layer independent from the cryptosystem to be used. Generic design schemes for two- and three-party protocols are being worked out and it is shown, how concrete specifications of new protocols may be derived easily. Doing this, specifications of new protocol are generated, for example a three-party private-key protocol.

The design is done by applying logical rules, starting from the protocol goals and prerequisites, which have been previously defined in a requirements definition. The author introduces a new representation technique for this. The author's approach is the inverse application of the popular logic of Burrows, Abadi and Needham, which has up to now been used for the verification of authentication and key-agreement protocols. The new method is called the inverse BAN logic. The representation of the protocol behaviour is done using the specification and description language SDL. This new representation is called "SDL combined with inverse BAN logic", SDL/iBAN. Furthermore, the author presents a development model, which enables a layered, general development of such protocols. [written in German]

Key words: Security protocols, authentication, key agreement, key distribution, formal methods, formal design,

BAN logic, Kerberos, SDL.

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Mathematical Foundations of Linguistics

H. Mark Hubey
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Only a few decades ago, only mathematicians, physicists and engineers took calculus courses, and calculus was tailored for them using examples from physics. This made it difficult for students from the life sciences including biology, economics, and psychology to learn mathematics. Recently books using examples from the life sciences and economics have become more popular for such students. Such a math book does not exist for linguists. Even the computational linguistics books (Formal Language Theory) are written for mathematicians and computer scientists.

This book is for linguists. It is intended to teach the required math for a student to be a scientific linguist and to make linguistics a science on par with economics, and computer science.

There are many concepts that are central to the sciences. Most students never see these in one place and if they do, they have to wait until graduate school to obtain them in the often-dreaded "quantitative" courses. As a result sometimes it takes years or even decades before learners are able to integrate what they have learned into a whole, if ever. We have little time and much to do.

In addition to all of these problems we are now awash in data and information. It is now that the general public should be made aware of the solution to all of these problems. The answer is obviously "knowledge compression". Knowledge is structured information; it is a system not merely a collection of interesting facts.

What this book does, and what all other math books do is teach people the tools with which they can structure and thus compress information and knowledge around them. It has also been said that mathematics is the science of patterns; it is exactly by finding such patterns that we compress knowledge. We can say that mathematics is the science of knowledge compression or information compression.

This book provides the basic tools for mathematics (even including a short and intuitive explanation of differential and integral calculus). The broad areas of linguistics, probability theory, speech synthesis, speech recognition, computational linguistics (formal languages and machines), historical linguistics require mathematics of counting/combinatorics, Bayesian theory, correlation-regression analysis, stochastic processes, differential equations, vectors/tensors. These in turn are based on set theory, logic, measurement theory, graph theory, algebra, Boolean algebra, harmonic analysis etc.

The mathematical fields introduced here are all common ideas from one which one can branch off into more advanced study in any of these fields thus this book brings together ideas from many disparate fields of mathematics which would not normally be put together into a single course. This is what makes this a book especially written for linguists.

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