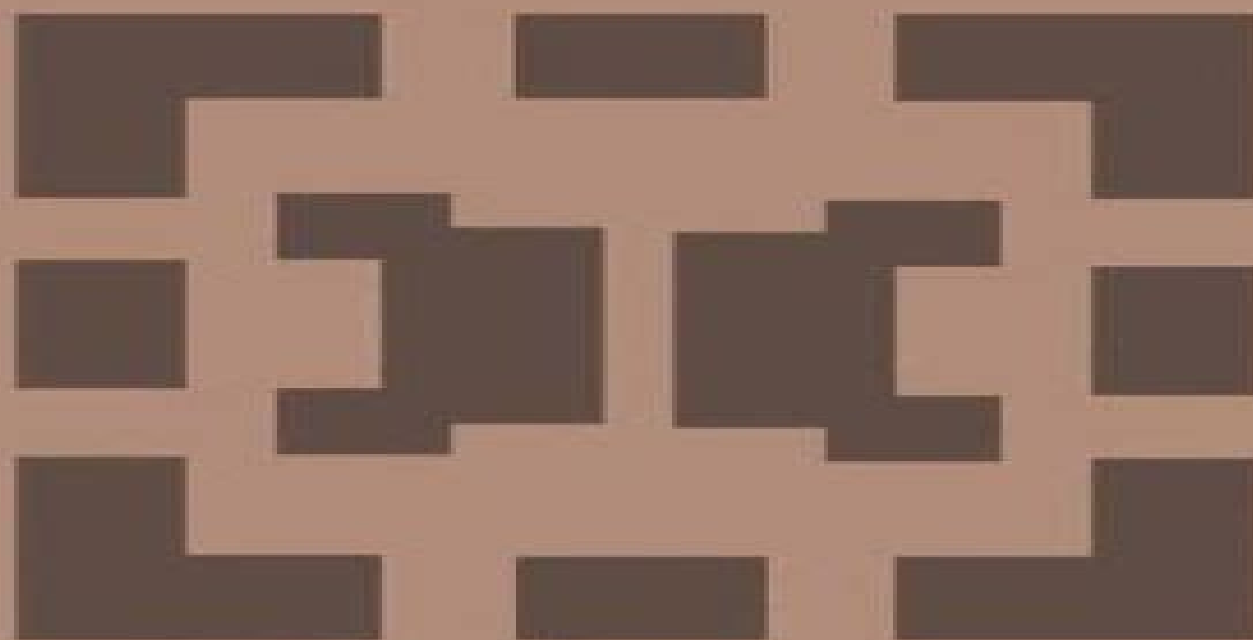


**Mathematics and Its Applications**

**Vassili N. Kolokoltsov and  
Victor P. Maslov**

**Idempotent Analysis  
and Its Applications**



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# Idempotent Analysis And Its Applications

**Henri Moscovici**



## **Idempotent Analysis And Its Applications:**

**Idempotent Analysis and Its Applications** Vasily Kolokoltsov, Victor P. Maslov, 1997-04-30 The first chapter deals with idempotent analysis per se To make the presentation self contained in the first two sections we define idempotent semirings give a concise exposition of idempotent linear algebra and survey some of its applications Idempotent linear algebra studies the properties of the semirules  $A^n \rightarrow E \rightarrow N$  over a semiring  $A$  with idempotent addition in other words it studies systems of equations that are linear in an idempotent semiring Probably the first interesting and nontrivial idempotent semiring namely that of all languages over a finite alphabet as well as linear equations in this semiring was examined by S Kleene 107 in 1956 This noncommutative semiring was used in applications to compiling and parsing see also 1 Presently the literature on idempotent algebra and its applications to theoretical computer science linguistic problems finite automata discrete event systems and Petri nets biomathematics logic mathematical physics mathematical economics and optimization is immense e.g see 9 10 11 12 13 15 16 17 22 31 32 35 36 37 38 39 40 41 52 53 54 55 61 62 63 64 68 71 72 73 74 77 78 79 80 81 82 83 84 85 86 88 114 125 128 135 136 138 139 141 159 160 167 170 173 174 175 176 177 178 179 180 185 186 187 188 189 In 1 2 we present the most important facts of the idempotent algebra formalism The semimodules  $A^n$  are idempotent analogs of the finite dimensional vector spaces  $\mathbb{R}^n$  and hence endomorphisms of these semimodules can naturally be called idempotent linear operators on  $A^n$

*Idempotent Analysis and Its Applications* Vasily Kolokoltsov, Victor P. Maslov, 2014-10-09 The first chapter deals with idempotent analysis per se To make the presentation self contained in the first two sections we define idempotent semirings give a concise exposition of idempotent linear algebra and survey some of its applications Idempotent linear algebra studies the properties of the semirules  $A^n \rightarrow E \rightarrow N$  over a semiring  $A$  with idempotent addition in other words it studies systems of equations that are linear in an idempotent semiring Probably the first interesting and nontrivial idempotent semiring namely that of all languages over a finite alphabet as well as linear equations in this semiring was examined by S Kleene 107 in 1956 This noncommutative semiring was used in applications to compiling and parsing see also 1 Presently the literature on idempotent algebra and its applications to theoretical computer science linguistic problems finite automata discrete event systems and Petri nets biomathematics logic mathematical physics mathematical economics and optimization is immense e.g see 9 10 11 12 13 15 16 17 22 31 32 35 36 37 38 39 40 41 52 53 54 55 61 62 63 64 68 71 72 73 74 77 78 79 80 81 82 83 84 85 86 88 114 125 128 135 136 138 139 141 159 160 167 170 173 174 175 176 177 178 179 180 185 186 187 188 189 In 1 2 we present the most important facts of the idempotent algebra formalism The semimodules  $A^n$  are idempotent analogs of the finite dimensional vector spaces  $\mathbb{R}^n$  and hence endomorphisms of these semimodules can naturally be called idempotent linear operators on  $A^n$

**Intelligent Systems: Models and Applications** Endre Pap, 2012-10-20 The theory and applications of intelligent systems is today an important field of research This book is an up to date collection of seventeen chapters written by recognized experts in the field In an introductory mathematical foundations part an overview

of generalizations of the integral inequalities for nonadditive integrals and a construction of the General Prioritized Fuzzy Satisfaction Problem is given Then different aspects of robotics are presented such as the differences between human beings and robots the motion of bipedal humanoid robots and an evaluation of different autonomous quadrotor flight controllers Also Fuzzy Systems are presented by a model of basic planar imprecise geometric objects allowing various applications in image analysis GIS and robotics as well as a type 2 fuzzy logic in a software library for developing perceptual computers and a two degree of freedom speed control solutions for a brushless Direct Current motor The book also presents recent applications in medicine such as a Virtual Doctor System methods for a face to face human machine interaction and an emotion estimation with applications for multiple diseases and the effect of the applied therapy The last part of the book covers different applications in transportation network monitoring and localization of pedestrians in images

*Understanding Game Theory: Introduction To The Analysis Of Many Agent Systems With Competition And Cooperation (Second Edition)* Vasily N Kolokoltsov, Oleg A Malafeyev, 2020-08-21 Steadily growing applications of game theory in modern science including psychology biology and economics require sources to provide rapid access in both classical tools and recent developments to readers with diverse backgrounds This book on game theory its applications and mathematical methods is written with this objective in mind The book gives a concise but wide ranging introduction to games including older pre game theory party games and more recent topics like elections and evolutionary games and is generously spiced with excursions into philosophy history literature and politics A distinguished feature is the clear separation of the text into two parts elementary and advanced which makes the book ideal for study at various levels Part I displays basic ideas using no more than four arithmetic operations and requiring from the reader only some inclination to logical thinking It can be used in a university degree course without any or minimal prerequisite in mathematics say in economics business systems biology as well as for self study by school teachers social and natural scientists businessmen or laymen Part II is a rapid introduction to the mathematical methods of game theory suitable for a mathematics degree course of various levels To stimulate the mathematical and scientific imagination graphics by a world renowned mathematician and mathematics imaging artist A T Fomenko are used The carefully selected works of this artist fit remarkably into the many ideas expressed in the book This new edition has been updated and enlarged In particular two new chapters were added on statistical limit of games with many agents and on quantum games reflecting possibly the two most stunning trends in the game theory of the 21st century

*Understanding Game Theory: Introduction To The Analysis Of Many Agent Systems With Competition And Cooperation* Vasily N Kolokoltsov, Oleg A Malafeyev, 2010-01-20 Steadily growing applications of game theory in modern science including psychology biology and economics require sources to provide rapid access in both classical tools and recent developments to readers with diverse backgrounds This book on game theory its applications and mathematical methods is written with this objective in mind The book gives a concise but wide ranging introduction to games including older pre game theory party

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A Guide to the Literature on Semirings and their Applications in Mathematics and Information Sciences K. Glazek, 2013-06-29 This volume presents a short guide to the extensive literature concerning semirings along with a complete bibliography The literature has been created over many years in variety of languages by authors representing different schools of mathematics and working in various related fields In many instances the terminology used is not universal which further compounds the difficulty of locating pertinent sources even in this age of the Internet and electronic dissemination of research results So far there has been no single reference that could guide the interested scholar or student to the relevant publications This book is an attempt to fill this gap My interest in the theory of semirings began in the early sixties when together with Bogdan W glorz I tried to investigate some algebraic aspects of compactifications of topological spaces semirings of semicontinuous functions and the general ideal theory for special semirings Unfortunately local algebraists in Poland told me at that time that there was nothing interesting in investigating semiring theory because ring theory was still being developed However some time later we became aware of some similar investigations having already been done The theory of semirings has remained my first love ever since and I have been interested in the results in this field that have been appearing in literature even though I have not been active in this area myself

Algebraic Integrability of Nonlinear Dynamical Systems on Manifolds A.K. Prykarpatsky, I.V. Mykytiuk, 2013-04-09 In recent times it has been stated that many dynamical systems of classical mathematical physics and mechanics are endowed with symplectic structures given in the majority of cases by Poisson brackets Very often such Poisson structures on corresponding manifolds are canonical which gives rise to the possibility of producing their hidden group theoretical essence for many completely integrable dynamical systems It is a well understood fact that great part of comprehensive integrability theories of nonlinear dynamical systems on manifolds is based on Lie algebraic ideas by means

of which in particular the classification of such compatibly bi Hamiltonian and isospectrally Lax type integrable systems has been carried out Many chapters of this book are devoted to their description but to our regret so far the work has not been completed Hereby our main goal in each analysed case consists in separating the basic algebraic essence responsible for the complete integrability and which is at the same time in some sense universal i e characteristic for all of them Integrability analysis in the framework of a gradient holonomic algorithm devised in this book is fulfilled through three stages 1 finding a symplectic structure Poisson bracket transforming an original dynamical system into a Hamiltonian form 2 finding first integrals action variables or conservation laws 3 defining an additional set of variables and some functional operator quantities with completely controlled evolutions for instance as Lax type representation

### **Graphs, Dioids and Semirings**

Michel Gondran, Michel Minoux, 2008-05-14 The primary objective of this essential text is to emphasize the deep relations existing between the semiring and dio d structures with graphs and their combinatorial properties It does so at the same time as demonstrating the modeling and problem solving flexibility of these structures In addition the book provides an extensive overview of the mathematical properties employed by nonclassical algebraic structures which either extend usual algebra or form a new branch of it

### **The Theory of Partial Algebraic Operations**

E.S. Ljapin, A.E. Evseev, 2013-04-17

Nowadays algebra is understood basically as the general theory of algebraic operations and relations It is characterised by a considerable intrinsic naturalness of its initial notions and problems the unity of its methods and a breadth that far exceeds that of its basic concepts It is more often that its power begins to be displayed when one moves outside its own limits This characteristic ability is seen when one investigates not only complete operations but partial operations To a considerable extent these are related to algebraic operators and algebraic operations The tendency to ever greater generality is amongst the reasons that play a role in explaining this development But other important reasons play an even greater role Within this same theory of total operations that is operations defined everywhere there persistently arises in its different sections a necessity of examining the emergent feature of various partial operations It is particularly important that this has been found in those parts of algebra it brings together and other areas of mathematics it interacts with as well as where algebra finds application at the very limits of mathematics In this connection we mention the theory of the composition of mappings category theory the theory of formal languages and the related theory of mathematical linguistics coding theory information theory and algebraic automata theory In all these areas as well as in others from time to time there arises the need to consider one or another partial operation

### Markov Processes, Semigroups, and Generators

Vassili N. Kolokoltsov, 2011

This work offers a highly useful well developed reference on Markov processes the universal model for random processes and evolutions The wide range of applications in exact sciences as well as in other areas like social studies require a volume that offers a refresher on fundamentals before conveying the Markov processes and examples for

Noncommutative Geometry and Global Analysis Henri Moscovici, 2011 This volume represents the proceedings of the conference on Noncommutative

Geometric Methods in Global Analysis held in honor of Henri Moscovici from June 29 July 4 2009 in Bonn Germany Henri Moscovici has made a number of major contributions to noncommutative geometry global analysis and representation theory This volume which includes articles by some of the leading experts in these fields provides a panoramic view of the interactions of noncommutative geometry with a variety of areas of mathematics It focuses on geometry analysis and topology of manifolds and singular spaces index theory group representation theory connections of noncommutative geometry with number theory and arithmetic geometry Hopf algebras and their cyclic cohomology

*Nonlinear Markov Processes and Kinetic Equations* Vassili N. Kolokoltsov, 2010-07-15 A nonlinear Markov evolution is a dynamical system generated by a measure valued ordinary differential equation with the specific feature of preserving positivity This feature distinguishes it from general vector valued differential equations and yields a natural link with probability both in interpreting results and in the tools of analysis This brilliant book the first devoted to the area develops this interplay between probability and analysis After systematically presenting both analytic and probabilistic techniques the author uses probability to obtain deeper insight into nonlinear dynamics and analysis to tackle difficult problems in the description of random and chaotic behavior The book addresses the most fundamental questions in the theory of nonlinear Markov processes existence uniqueness constructions approximation schemes regularity law of large numbers and probabilistic interpretations Its careful exposition makes the book accessible to researchers and graduate students in stochastic and functional analysis with applications to mathematical physics and systems biology

Semidistributive Modules and Rings A.A. Tuganbaev, 2012-12-06 A module  $M$  is called distributive if the lattice  $\text{Lat } M$  of all its submodules is distributive i e  $F \cap G = (F \cap H) \cap G$  for all submodules  $F, G$  and  $H$  of the module  $M$  A module  $M$  is called uniserial if all its submodules are comparable with respect to inclusion i e the lattice  $\text{Lat } M$  is a chain Any direct sum of distributive resp uniserial modules is called a semidistributive resp serial module The class of distributive resp semidistributive modules properly contains the class of all uniserial resp serial modules In particular all simple resp semisimple modules are distributive resp semidistributive All strongly regular rings for example all factor rings of direct products of division rings and all commutative regular rings are distributive all valuation rings in division rings and all commutative Dedekind rings e g rings of integral algebraic numbers or commutative principal ideal rings are distributive A module is called a Bezout module or a locally cyclic module if every finitely generated submodule is cyclic If all maximal right ideals of a ring  $A$  are ideals e g if  $A$  is commutative then all Bezout  $A$  modules are distributive

**Relational and Algebraic Methods in Computer Science** Peter Höfner, Peter Jipsen, Wolfram Kahl, Martin Eric Müller, 2014-04-08 This book constitutes the proceedings of the 14th International Conference on Relational and Algebraic Methods in Computer Science RAMiCS 2014 held in Marienstatt Germany in April May 2014 The 25 revised full papers presented were carefully selected from 37 submissions The papers are structured in specific fields on concurrent Kleene algebras and related formalisms reasoning about computations and

programs heterogeneous and categorical approaches applications of relational and algebraic methods and developments related to modal logics and lattices

**Handbook of Linear Algebra** Leslie Hogben, 2006-11-02 The Handbook of Linear Algebra provides comprehensive coverage of linear algebra concepts applications and computational software packages in an easy to use handbook format The esteemed international contributors guide you from the very elementary aspects of the subject to the frontiers of current research The book features an accessible

**Handbook of Mathematical Models and Algorithms in Computer Vision and Imaging** Ke Chen, Carola-Bibiane Schönlieb, Xue-Cheng Tai, Laurent Younes, 2023-02-24 This handbook gathers together the state of the art on mathematical models and algorithms for imaging and vision Its emphasis lies on rigorous mathematical methods which represent the optimal solutions to a class of imaging and vision problems and on effective algorithms which are necessary for the methods to be translated to practical use in various applications Viewing discrete images as data sampled from functional surfaces enables the use of advanced tools from calculus functions and calculus of variations and nonlinear optimization and provides the basis of high resolution imaging through geometry and variational models Besides optimization naturally connects traditional model driven approaches to the emerging data driven approaches of machine and deep learning No other framework can provide comparable accuracy and precision to imaging and vision Written by leading researchers in imaging and vision the chapters in this handbook all start with gentle introductions which make this work accessible to graduate students For newcomers to the field the book provides a comprehensive and fast track introduction to the content to save time and get on with tackling new and emerging challenges For researchers exposure to the state of the art of research works leads to an overall view of the entire field so as to guide new research directions and avoid pitfalls in moving the field forward and looking into the next decades of imaging and information services This work can greatly benefit graduate students researchers and practitioners in imaging and vision applied mathematicians medical imagers engineers and computer scientists

**Modeling Decisions for Artificial Intelligence** Vincenc Torra, Yasuo Narukawa, Guillermo Navarro-Arribas, David Megías, 2014-07-08 This book constitutes the proceedings of the 10th International Conference on Modeling Decisions for Artificial Intelligence MDAI 2013 held in Barcelona Spain in November 2013 The 24 papers presented in this volume were carefully reviewed and selected from 40 submissions They deal with the theory and tools for modeling decisions as well as applications that encompass decision making processes and information fusion techniques

**Non-diophantine Arithmetics In Mathematics, Physics And Psychology** Mark Burgin, Marek Czachor, 2020-11-04 For a long time all thought there was only one geometry Euclidean geometry Nevertheless in the 19th century many non Euclidean geometries were discovered It took almost two millennia to do this This was the major mathematical discovery and advancement of the 19th century which changed understanding of mathematics and the work of mathematicians providing innovative insights and tools for mathematical research and applications of mathematics A similar event happened in arithmetic in the 20th century Even longer than with geometry all



thought there was only one conventional arithmetic of natural numbers the Diophantine arithmetic in which  $2^2 + 4^2 = 1^2 + 1^2 + 2^2$  It is natural to call the conventional arithmetic by the name Diophantine arithmetic due to the important contributions to arithmetic by Diophantus Nevertheless in the 20th century many non Diophantine arithmetics were discovered in some of which  $2^2 + 5^2 = 1^2 + 1^2 + 3^2$  It took more than two millennia to do this This discovery has even more implications than the discovery of new geometries because all people use arithmetic This book provides a detailed exposition of the theory of non Diophantine arithmetics and its various applications Reading this book the reader will see that on the one hand non Diophantine arithmetics continue the ancient tradition of operating with numbers while on the other hand they introduce extremely original and innovative ideas

**Artificial Intelligence: Theory and Applications** Endre Pap, 2021-07-15 This book is an up to date collection in AI and environmental research related to the project ATLAS AI is used for gaining an understanding of complex research phenomena in the environmental sciences encompassing heterogeneous noisy inaccurate uncertain diverse spatio temporal data and processes The first part of the book covers new mathematics in the field of AI aggregation functions with special classes such as triangular norms and copulas pseudo analysis and the introduction to fuzzy systems and decision making Generalizations of the Choquet integral with applications in decision making as CPT are presented The second part of the book is devoted to AI in the geo referenced air pollutants and meteorological data image processing machine learning neural networks swarm intelligence robotics mental well being and data entry errors The book is intended for researchers in AI and experts in environmental sciences as well as for Ph D students

Dynamical Systems S.-N. Chow, Roberto Conti, R. Johnson, J. Mallet-Paret, R. Nussbaum, 2003-12-10 The C I M E session on Dynamical Systems held in Cetraro Italy June 19 26 2000 focused on the latest developments in several important areas in dynamical systems with full development and historical context The lectures of Chow and Mallet Paret focus on the area of lattice differential systems the lectures of Conto and Galleotti treat the classical problem of classification of orbits for two dimensional autonomous systems with polynomial right sides the lectures of Nussbaum focus on applications of fixed point theorems to the problem of limiting profiles for the solutions of singular perturbations of delay differential equations and the lectures of Johnson and Mantellini deal with the existence of periodic and quasi periodic orbits to non autonomous systems The volume will be of interest to researchers and graduate students working in these areas

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