

Lecture Notes in Morphogenesis
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Giovanna Citti
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Neuromathematics of Vision



Springer

Neuromathematics Of Vision Lecture Notes In Morphogenesis

Richard A. Clement



Neuromathematics Of Vision Lecture Notes In Morphogenesis:

Neuromathematics of Vision Giovanna Citti, Alessandro Sarti, 2014-02-08 This book is devoted to the study of the functional architecture of the visual cortex Its geometrical structure is the differential geometry of the connectivity between neural cells This connectivity is building and shaping the hidden brain structures underlying visual perception The story of the problem runs over the last 30 years since the discovery of Hubel and Wiesel of the modular structure of the primary visual cortex and slowly came towards a theoretical understanding of the experimental data on what we now know as functional architecture of the primary visual cortex Experimental data comes from several domains neurophysiology phenomenology of perception and neurocognitive imaging Imaging techniques like functional MRI and diffusion tensor MRI allow to deepen the study of cortical structures Due to this variety of experimental data neuromathematics deals with modelling both cortical structures and perceptual spaces From the mathematical point of view neuromathematical call for new instruments of pure mathematics sub Riemannian geometry models horizontal connectivity harmonic analysis in non commutative groups allows to understand pinwheels structure as well as non linear dimensionality reduction is at the base of many neural morphologies and possibly of the emergence of perceptual units But at the center of the neurogeometry is the problem of harmonizing contemporary mathematical instruments with neurophysiological findings and phenomenological experiments in an unitary science of vision The contributions to this book come from the very founders of the discipline

Harmonic and Geometric Analysis Giovanna Citti, Loukas Grafakos, Carlos Pérez, Alessandro Sarti, Xiao Zhong, 2015-04-28 This book contains an expanded version of lectures delivered by the authors at the CRM in Spring of 2009 It contains four series of lectures The first one is an application of harmonic analysis and the Heisenberg group to understand human vision The second and third series of lectures cover some of the main topics on linear and multilinear harmonic analysis The last one is a clear introduction to a deep result of De Giorgi Moser and Nash on regularity of elliptic partial differential equations in divergence form

Morphology, Neurogeometry, Semiotics Alessandro Sarti, 2024-06-03 Jean Petitot is a polyhedric thinker whose contributions has been fundamental in a number of disciplines such as epistemology morphodynamics differential geometry structural semiotics neurogeometry phenomenology linguistics cognitive grammars the theory of catastrophes social sciences literary studies and aesthetics This book is a homage to his huge contribution about the main concepts of morphogenesis and meaning that constitute the center of gravity around which Petitotian reflection revolves and returns The scientific path of Jean Petitot develops between these two poles topology and meaning At stake it was to challenge the hiatus separating the exact sciences from the humanities that was the main point of the Petitot seminar of EHESS Epistemology of Models By designing the appropriate qualitative dynamics between the two poles form and meaning it is possible to understand the Saussurian sign in structural semiotics or the Greimasian semiotic square for deep narrative structures or even the canonical formula of the myth of L vi Strauss in structural anthropology These are just few results in

applying the theory of catastrophes to the emergence of meaning The book is a collection of testimonies by distinguished authors who worked extensively with Jean Petitot in the different fields of Mathematics Neurogeometry Semiotics Aesthetics and Epistemology An extensive bibliography of Petitot's work is also presented

Elements of Neurogeometry Jean Petitot, 2017-11-08 This book describes several mathematical models of the primary visual cortex referring them to a vast ensemble of experimental data and putting forward an original geometrical model for its functional architecture that is the highly specific organization of its neural connections The book spells out the geometrical algorithms implemented by this functional architecture or put another way the neurogeometry immanent in visual perception Focusing on the neural origins of our spatial representations it demonstrates three things firstly the way the visual neurons filter the optical signal is closely related to a wavelet analysis secondly the contact structure of the 1 jets of the curves in the plane the retinal plane here is implemented by the cortical functional architecture and lastly the visual algorithms for integrating contours from what may be rather incomplete sensory data can be modelled by the sub Riemannian geometry associated with this contact structure As such it provides readers with the first systematic interpretation of a number of important neurophysiological observations in a well defined mathematical framework The book's neuromathematical exploration appeals to graduate students and researchers in integrative functional cognitive neuroscience with a good mathematical background as well as those in applied mathematics with an interest in neurophysiology

Morphogenesis of Symbolic Forms: Meaning in Music, Art, Religion, and Language Wolfgang Wildgen, 2023-03-01 In the present book the starting line is defined by a morphogenetic perspective on human communication and culture The focus is on visual communication music religion myth and language i e on the symbolic forms at the heart of human cultures Ernst Cassirer The term morphogenesis has more precisely the meaning given by Ren Thom 1923 2002 in his book Morphogenesis and Structural Stability 1972 and the notions of self organization and cooperation of subsystems in the Synergetics of Hermann Haken 1927 The naturalization of communication and cultural phenomena is the favored strategy but the major results of the involved disciplines art history music theory religious science and linguistics are respected Visual art from the Paleolithic to modernity stands for visual communication The present book focuses on studies of classical painting and sculpture e g Leonardo da Vinci William Turner and Henry Moore and modern art e g Jackson Pollock and Joseph Beuys Musical morphogenesis embraces classical music from J S Bach to Arnold Sch nberg and political songwriting Bob Dylan Leonhard Cohen The myths of pre literary societies show the effects of self organization in the re assembly bricolage of traditions Classical polytheistic and monotheistic religions demonstrate the unfolding of basic germs religious attractors and their reduction in periods of crisis the self organization of complex religious networks and rationalized macro structures in theologies Significant tendencies are analyzed in the case of Buddhism and Christianity Eventually a holistic view of symbolic communication and human culture emerges based on state of the art in evolutionary biology cognitive science linguistics and semiotics philosophy of symbolic

forms **Semiotic Perception and Dynamic Forms of Meaning** Antonino Bondi, David Piotrowski, Yves-Marie Visetti, 2023-09-23 What do we mean by semiotic perception Why should the concepts of perception and expressivity be reinterpreted within the encompassing framework of a dynamic theory of semiotic fields and forms Can we redeploy the concept of form in such a way as to make explicit such a native solidarity chiasmatic would have said Merleau Ponty between perception praxis and expression and first and foremost in the activity of language right to the heart of the life of the social and speaking animal that we are What then would be the epistemological and ontological consequences and how might this affect the way we describe semiolinguistic forms This book aims to provide answers to these questions by opening up avenues of research on how to understand the linguistic and semiotic dimensions at work in the constitution of experience both individual and collective *Differential Heterogenesis* Alessandro Sarti, Giovanna Citti, David Piotrowski, 2022-07-15 This book describes about unlike usual differential dynamics common in mathematical physics heterogenesis is based on the assemblage of differential constraints that are different from point to point The construction of differential assemblages will be introduced in the present study from the mathematical point of view outlining the heterogeneity of the differential constraints and of the associated phase spaces that are continuously changing in space and time If homogeneous constraints well describe a form of swarm intelligence or crowd behaviour it reduces dynamics to automatisms by excluding any form of imaginative and creative aspect With this study we aim to problematize the procedure of homogeneization that is dominant in life and social science and to outline the dynamical heterogeneity of life and its affective semiotic social historical aspects Particularly the use of sub Riemannian geometry instead of Riemannian one allows to introduce disjointed and autonomous areas in the virtual plane Our purpose is to free up the dynamic becoming from any form of unitary and totalizing symmetry and to develop forms action thought by means of proliferation juxtaposition and disjunction devices After stating the concept of differential heterogenesis with the language of contemporary mathematics we will face the problem of the emergence of the semiotic function recalling the limitation of classical approaches Hjeltmslev Saussure Husserl and proposing a possible genesis of it from the heterogenetic flow previously defined We consider the conditions under which this process can be polarized to constitute different planes of Content C and Expression E each one equipped with its own formed substances A possible but not unique process of polarization is constructed by means of spectral analysis that is introduced to individuate E C planes and their evolution The heterogenetic flow solution of differential assemblages gives rise to forms that are projected onto the planes offering a first referring system for the flow that constitutes a first degree of semiosis Diagrams and Gestures Francesco La Mantia, Charles Alunni, Fernando Zalamea, 2023-09-16 Drawing a line and then another and another Go back from the lines to the movements they capture and see gestures in them not spatial displacements but modes of knowledge that pass through the exercise of the body Discovering something new in a gesture the line that contracts into a point or the point that expands into a zone perhaps sinking into a hole Thus experiencing a diagram a becoming other

inscribed in the novelty of the gesture and in the changes of the forms it shapes This and much more is discussed in the essays gathered in *Diagrams and Gestures* Resulting from trans disciplinary work between mathematicians philosophers linguists and semioticians the volume delivers an up to date account of the most valuable research on the connections between gesture and diagram As one of the most important themes in contemporary thought the study of these connections poses a challenge for the future to elaborate a theory that is equal to new and stimulating research methodologies We call this theory a philosophy of diagrammatic gestures

The Relevance of René Thom Isabel Marcos, Clément Morier, 2024-08-29 The body of work presented in this book comes from research carried out since 2017 as part of the international Actualité de René Thom project This project was initially entitled Morphology and qualitative dynamics Knowledge of forms Forms of knowledge Subsequently the name Relevance of René Thom was chosen for its clarity and evocative power The aim of this research project is to promote the scientific relevance of René Thom's thinking on forms and to demonstrate the importance of his method and discoveries It is based on discussions of Thom's thinking and the method he proposes i.e. to seek out dynamic structures in order to understand changes of form in nature and at the human social level to explain the transformation of these dynamic forms to study the morphologies of process in various fields in order to advance scientific knowledge The relevance of this thinker has manifested itself in the form of monthly sessions of a research seminar held from 2017 to 2022 as well as in the form of international congresses 2018 2019 bringing together the greatest friends and continuators both of the work of René Thom himself and of reflection on morphogenetic dynamics in the most diverse disciplines This created a space for dialogue and listening between the exact sciences and the social and human sciences Indeed the fields of study are necessarily interdisciplinary since as René Thom teaches us morphological organization or form in its exchanges with matter must be considered as independent of its substrate i.e. the environment in which this morphogenesis unfolds Finally this book marks a symbolic moment it takes shape in the year that marks the centenary of the birth of René Thom who was born in the French town of Montbliard in 1923 To mark this centenary 1923 2023 a number of initiatives have been launched to celebrate the discoveries and advances of this mathematician philosopher as he liked to call himself The publication of the present book is one more which we hope will shed light that will stimulate the morphological gaze Thom so urged us to adopt

Mathematical Tools for Neuroscience Richard A. Clement, 2022-04-21 This book provides a brief but accessible introduction to a set of related mathematical ideas that have proved useful in understanding the brain and behaviour If you record the eye movements of a group of people watching a riverside scene then some will look at the river some will look at the barge by the side of the river some will look at the people on the bridge and so on but if a duck takes off then everybody will look at it How come the brain is so adept at processing such biological objects In this book it is shown that brains are especially suited to exploiting the geometric properties of such objects Central to the geometric approach is the concept of a manifold which extends the idea of a surface to many dimensions The manifold can be specified

by collections of n dimensional data points or by the paths of a system through state space Just as tangent planes can be used to analyse the local linear behaviour of points on a surface so the extension to tangent spaces can be used to investigate the local linear behaviour of manifolds The majority of the geometric techniques introduced are all about how to do things with tangent spaces Examples of the geometric approach to neuroscience include the analysis of colour and spatial vision measurements and the control of eye and arm movements Additional examples are used to extend the applications of the approach and to show that it leads to new techniques for investigating neural systems An advantage of following a geometric approach is that it is often possible to illustrate the concepts visually and all the descriptions of the examples are complemented by comprehensively captioned diagrams The book is intended for a reader with an interest in neuroscience who may have been introduced to calculus in the past but is not aware of the many insights obtained by a geometric approach to the brain Appendices contain brief reviews of the required background knowledge in neuroscience and calculus

Theories and Models of Urbanization Denise Pumain, 2020-01-02 This book provides a thorough discussion about fundamental questions regarding urban theories and modeling It is a curated collection of contributions to a workshop held in Paris on October 12th and 13th 2017 at the Institute of Complex Systems by the team of ERC GeoDiverCity There are several chapters conveying the answers given by single authors to problems of conceptualization and modeling and others in which scholars reply to their conception and question them Even the chapters transcribing keynote presentations were rewritten according to contributions from the respective discussions The result is a complete state of the art of what is our knowledge about urban processes and their possible formalization

Glossary of Morphology Federico Vercellone, Salvatore Tedesco, 2020-12-01 This book is a significant novelty in the scientific and editorial landscape Morphology is both an ancient and a new discipline that rests on Goethe's heritage and re-forms it in the present through the concepts of form and image The latter are to be understood as structural elements of a new cultural grammar able to make the late modern world intelligible In particular compared to the original Goethean project but also to C P Snow's idea of unifying the two cultures the fields of morphological culture that are the object of this glossary have profoundly changed The ever increasing importance of the image as a polysemic form has made the two concepts absolutely transitive so to speak This is concomitant with the emergence of a culture that revolves around the image attracting the verbal logos into its orbit Incidentally even the hermeneutic relationship between past and present relies more and more on the image causing deep changes in cultural environments Form and image are not just bridging concepts as in the field of ancient morphology but real transitive concepts that define the state of a culture From the Internet to smartphones television advertising etc we are witnessing as Horst Bredekamp observes an immense mass of images that fill our time and affect the most diverse areas of our culture The ancient connection between science and art recalled by Goethe emerges with unusual evidence thanks to intersecting patterns and expressive forms that are sometimes shared by different forms of knowledge Creating a glossary

and a culture of these intersections is the task of morphology which thus enters into the boundaries between aesthetics art design advertising and sciences from mathematics to computer science to physics and to biology in order to provide the founding elements of a grammar and a syntax of the image The latter in its formal quality both expressive and symbolic is a fundamental element in the unification of the various kinds of knowledge which in turn come to be configured in this regard also as styles of vision The glossary is subdivided into contiguous sections within a complex framework of cross references In addition to the two curators the book features the collaboration of a team of scholars from the individual disciplines appearing in the glossary

Quantitative Semiotic Analysis Dario Compagno, 2018-01-16 This contributed volume gives access to semiotic researches adopting a quantitative stance European semiotics is traditionally based on immanent methodologies meaning is seen as an autonomous dimension of human existence whose laws can be investigated via purely qualitative analytical and reflexive analysis Today researches crossing disciplinary boundaries reveal the limitations of such an homogeneous practice In particular two families of quantitative research strategies can be identified On the one hand researchers wish to naturalize meaning by making semiotic results interact with those coming from Neurophysiological and psychological sciences On the other hand statistical and computational tools are adopted to work on linguistic and multimedia corpora The book acts to put the two approaches into dialogue

Literary Heterogenesis Noëlle Batt, 2024-08-24 This book advances a new interdisciplinary approach that engages with the concepts of science and literature through the mediation of philosophy with a focus on the ideas of Gilbert Simondon and Gilles Deleuze It investigates in innovative ways the multifaceted dimensions of creation of genesis considered here in artistic and mathematical terms as heterogenesis The dialogic interaction among the three domains generates a renewed analysis of poems selected in the work of particularly inventive poets both French and American Emily Dickinson e e cummings and Francis Ponge as well as the artwork of Pierre Soulages Anna Eva Bergman and Cy Twombly

Literary Heterogenesis Diagrammatic Dynamics The Interplay of the Virtual and the Actual will interest specialists of mathematics physics literary theory and criticism philosophy and epistemology It will also attract any curious mind drawn to the bridging of disciplines and the concepts of the two cultures

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