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Mathematical Aspects of Spin Glasses and Neural Networks

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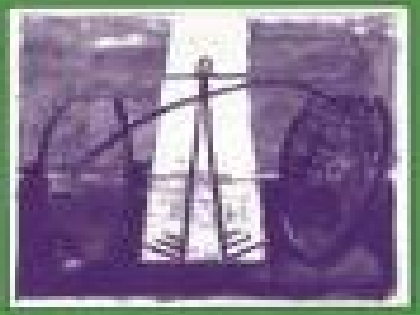

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Mathematical Aspects Of Spin Glasses And Neural Networks

Michel Talagrand

Mathematical Aspects Of Spin Glasses And Neural Networks:

Mathematical Aspects of Spin Glasses and Neural Networks Anton Bovier,Pierre Picco,2012-12-06 **Mathematical Aspects of Spin Glasses and Neural Networks** Anton Bovier,Pierre Picco,1998 Spin Glasses: A Challenge for Mathematicians Michel Talagrand,2003-07-11 In the eighties a group of theoretical physicists introduced several models for certain disordered systems called spin glasses These models are simple and rather canonical random structures that physicists studied by non rigorous methods They predicted spectacular behaviors previously unknown in probability theory They believe these behaviors occur in many models of considerable interest for several branches of science statistical physics neural networks and computer science This book introduces in a rigorous manner this exciting new area to the mathematically minded reader It requires no knowledge whatsoever of any physics and contains proofs in complete detail of much of what is rigorously known on spin glasses at the time of writing **Mean Field Models for Spin Glasses** Michel Talagrand,2010-11-10 This is a new completely revised updated and enlarged edition of the author s Ergebnisse vol 46 Spin Glasses A Challenge for Mathematicians This new edition will appear in two volumes the present first volume presents the basic results and methods the second volume is expected to appear in 2011 In the eighties a group of theoretical physicists introduced several models for certain disordered systems called spin glasses These models are simple and rather canonical random structures of considerable interest for several branches of science statistical physics neural networks and computer science The physicists studied them by non rigorous methods and predicted spectacular behaviors This book introduces in a rigorous manner this exciting new area to the mathematically minded reader It requires no knowledge whatsoever of any physics The first volume of this new and completely rewritten edition presents six fundamental models and the basic techniques to study them Spin Glasses: Statics and Dynamics Anne Boutet de Monvel,Anton Bovier,2009-12-15 Over the last decade spin glass theory has turned from a fascinating part of t oretical physics to a ourishing and rapidly growing subject of probability theory as well These developments have been triggered to a large part by the mathem ical understanding gained on the fascinating and previously mysterious Parisi solution of the Sherrington Kirkpatrick mean eld model of spin glasses due to the work of Guerra Talagrand and others At the same time new aspects and applications of the methods developed there have come up The presentvolumecollects a number of reviewsaswellas shorterarticlesby lecturers at a summer school on spin glasses that was held in July 2007 in Paris These articles range from pedagogical introductions to state of the art papers covering the latest developments In their whole they give a nice overview on the current state of the eld from the mathematical side The review by Bovier and Kurkova gives a concise introduction to mean eld models starting with the Curie Weiss model and moving over the Random Energymodels up to the Parisisolutionof the Sherrington Kirkpatrikmodel Ben Arous and Kuptsov present a more recent view and disordered systems through the so called local energy statistics They emphasize that there are many ways to look at Hamiltonians of disordered systems that make appear

the Random Energy model or independent random variables as a universal mechanism for describing certain rare events An important tool in the analysis of spin glasses are correlation identities **Spin Glasses** Erwin Bolthausen,Anton Bovier,2007-01-11 This book serves as a concise introduction to the state of the art of spin glass theory The collection of review papers are written by leading experts in the field and cover the topic from a wide variety of angles The book will be useful to both graduate students and young researchers as well as to anyone curious to know what is going on in this exciting area of mathematical physics **Mathematical Physics and Stochastic Analysis** Sergio Albeverio,2000 In October 1998 a conference was held in Lisbon to celebrate Ludwig Streit s 60th birthday This book collects some of the papers presented at the conference as well as other essays contributed by the many friends and collaborators who wanted to honor Ludwig Streit s scientific career and personality The contributions cover many aspects of contemporary mathematical physics Of particular importance are new results on infinite dimensional stochastic analysis and its applications to a wide range of physical domains List of Contributors S Albeverio T Hida L Accardi I Ya Aref eva I V Volovich A Daletskii Y Kondratiev W Karwowski N Asai I Kubo H H Kuo J Beckers Ph Blanchard G F Dell Antonio D Gandolfo M Sirugue Collin A Bohm H Kaldass D Boll G Jongen G M Shim J Bornales C C Bernido M V Carpio Bernido G Burdet Ph Combe H Nencka P Cartier C DeWitt Morette H Ezawa K Nakamura K Watanabe Y Yamanaka R Figari F Gesztesy H Holden R Gielerak G A Goldin Z Haba M O Hongler Y Hu B Oksendal A Sulem J R Klauder C B Lang V I Man ko H Ouerdiane J Potthoff E Smajlovic M R ckner E Scacciatelli J L Silva J Stochel F H Szafraniec L V zquez D N Kozakevich S Jim nez V R Vieira P D Sacramento R Vilela Mendes D Voln P Samek **Geometric Aspects of Functional Analysis** Vitali D. Milman,Gideon Schechtman,2004-08-30 The Israeli GAFA seminar on Geometric Aspect of Functional Analysis during the years 2002 2003 follows the long tradition of the previous volumes It reflects the general trends of the theory Most of the papers deal with different aspects of the Asymptotic Geometric Analysis In addition the volume contains papers on related aspects of Probability classical Convexity and also Partial Differential Equations and Banach Algebras There are also two expository papers on topics which proved to be very much related to the main topic of the seminar One is Statistical Learning Theory and the other is Models of Statistical Physics All the papers of this collection are original research papers *Statistical Mechanics of Disordered Systems* Anton Bovier,2006-06-08 Publisher Description **Dynamics & Stochastics** Michael S. Keane,Dee Denteneer,Frank Hollander,Evgeny Verbitskiy,2006 **Mathematical Aspects of Deep Learning** Philipp Grohs,Gitta Kutyniok,2022-12-22 In recent years the development of new classification and regression algorithms based on deep learning has led to a revolution in the fields of artificial intelligence machine learning and data analysis The development of a theoretical foundation to guarantee the success of these algorithms constitutes one of the most active and exciting research topics in applied mathematics This book presents the current mathematical understanding of deep learning methods from the point of view of the leading experts in the field It serves both as a starting point for researchers and graduate students in

computer science mathematics and statistics trying to get into the field and as an invaluable reference for future research

Sojourns in Probability Theory and Statistical Physics - III Vladas Sidoravicius,2019-10-17 Charles M Chuck Newman has been a leader in Probability Theory and Statistical Physics for nearly half a century This three volume set is a celebration of the far reaching scientific impact of his work It consists of articles by Chuck s collaborators and colleagues across a number of the fields to which he has made contributions of fundamental significance This publication was conceived during a conference in 2016 at NYU Shanghai that coincided with Chuck s 70th birthday The sub titles of the three volumes are I Spin Glasses and Statistical Mechanics II Brownian Web and Percolation III Interacting Particle Systems and Random Walks The articles in these volumes which cover a wide spectrum of topics will be especially useful for graduate students and researchers who seek initiation and inspiration in Probability Theory and Statistical Physics *European Congress of Mathematics* Ari Laptev,2005 The European Congress of Mathematics held every four years has established itself as a major international mathematical event Following those in Paris 1992 Budapest 1996 and Barcelona 2000 the Fourth European Congress of Mathematics took place in Stockholm Sweden June 27 to July 2 2004 with 913 participants from 65 countries Apart from seven plenary and thirty three invited lectures there were six Science Lectures covering the most relevant aspects of mathematics in science and technology Moreover twelve projects of the EU Research Training Networks in Mathematics and Information Sciences as well as Programmes from the European Science Foundation in Physical and Engineering Sciences were presented Ten EMS Prizes were awarded to young European mathematicians who have made a particular contribution to the progress of mathematics Five of the prizewinners were independently chosen by the 4ECM Scientific Committee as plenary or invited speakers The other five prizewinners gave their lectures in parallel sessions Most of these contributions are now collected in this volume providing a permanent record of so much that is best in mathematics today An Introduction to the Theory of Spin Glasses and Neural Networks Viktor Dotsenko,1994 This book aims to describe in simple terms the new area of statistical mechanics known as spin glasses encompassing systems in which quenched disorder is the dominant factor The book begins with a non mathematical explanation of the problem and the modern understanding of the physics of the spin glass state is formulated in general terms Next the magic of the replica symmetry breaking scheme is demonstrated and the physics behind it discussed Recent experiments on real spin glass materials are briefly described to demonstrate how this somewhat abstract physics can be studied in the laboratory The final chapters of the book are devoted to statistical models of neural networks The material here is self contained and should be accessible to students with a basic knowledge of theoretical physics and statistical mechanics It has been used for a one term graduate lecture course at the Landau Institute for Theoretical Physics **Probabilistic Behavior of Harmonic Functions** Rodrigo Banuelos,Charles N. Moore,1999-08 Harmonic analysis and probability have long enjoyed a mutually beneficial relationship that has been rich and fruitful This monograph aimed at researchers and students in these fields

explores several aspects of this relationship The primary focus of the text is the nontangential maximal function and the area function of a harmonic function and their probabilistic analogues in martingale theory The text first gives the requisite background material from harmonic analysis and discusses known results concerning the nontangential maximal function and area function as well as the central and essential role these have played in the development of the field The book next discusses further refinements of traditional results among these are sharp good lambda inequalities and laws of the iterated logarithm involving nontangential maximal functions and area functions Many applications of these results are given Throughout the constant interplay between probability and harmonic analysis is emphasized and explained The text contains some new and many recent results combined in a coherent presentation Probability on Discrete Structures Harry Kesten,2013-03-14 Most probability problems involve random variables indexed by space and or time These problems almost always have a version in which space and or time are taken to be discrete This volume deals with areas in which the discrete version is more natural than the continuous one perhaps even the only one than can be formulated without complicated constructions and machinery The 5 papers of this volume discuss problems in which there has been significant progress in the last few years they are motivated by or have been developed in parallel with statistical physics They include questions about asymptotic shape for stochastic growth models and for random clusters existence location and properties of phase transitions speed of convergence to equilibrium in Markov chains and in particular for Markov chains based on models with a phase transition cut off phenomena for random walks The articles can be read independently of each other Their unifying theme is that of models built on discrete spaces or graphs Such models are often easy to formulate Correspondingly the book requires comparatively little previous knowledge of the machinery of probability *New Trends in Mathematical Physics* Vladas Sidoravicius,2009-08-31 This book collects selected papers written by invited and plenary speakers of the 15th International Congress on Mathematical Physics ICMP in the aftermath of the conference In extensive review articles and expository texts as well as advanced research articles the world leading experts present the state of the art in modern mathematical physics New mathematical concepts and ideas are introduced by prominent mathematicalphysicists and mathematicians covering among others the fields of Dynamical Systems Operator Algebras Partial Differential Equations Probability Theory Random Matrices Condensed Matter Physics Statistical Mechanics General Relativity Quantum Mechanics Quantum Field Theory Quantum Information and String Theory All together the contributions in this book give a panoramic view of the latest developments in mathematical physics They will help readers with a general interest in mathematical physics to get an update on the most recent developments in their field and give a broad overview on actual and future research directions in this fascinating and rapidly expanding area **Metastability** Anton Bovier,Frank den Hollander,2016-02-11 This monograph provides a concise presentation of a mathematical approach to metastability a wide spread phenomenon in the dynamics of non linear systems physical chemical biological or economic subject to the action of

temporal random forces typically referred to as noise based on potential theory of reversible Markov processes The authors shed new light on the metastability phenomenon as a sequence of visits of the path of the process to different metastable sets and focuses on the precise analysis of the respective hitting probabilities and hitting times of these sets The theory is illustrated with many examples ranging from finite state Markov chains finite dimensional diffusions and stochastic partial differential equations via mean field dynamics with and without disorder to stochastic spin flip and particle hop dynamics and probabilistic cellular automata unveiling the common universal features of these systems with respect to their metastable behaviour The monograph will serve both as comprehensive introduction and as reference for graduate students and researchers interested in metastability Complex Systems Science in Biomedicine Thomas Deisboeck,J. Yasha Kresh,2007-06-13 Complex Systems Science in Biomedicine Thomas S Deisboeck and J Yasha Kresh Complex Systems Science in Biomedicine covers the emerging field of systems science involving the application of physics mathematics engineering and computational methods and techniques to the study of biomedicine including nonlinear dynamics at the molecular cellular multi cellular tissue and organismic level With all chapters helmed by leading scientists in the field Complex Systems Science in Biomedicine s goal is to offer its audience a timely compendium of the ongoing research directed to the understanding of biological processes as whole systems instead of as isolated component parts In Parts I II Complex Systems Science in Biomedicine provides a general systems thinking perspective and presents some of the fundamental theoretical underpinnings of this rapidly emerging field Part III then follows with a multi scaled approach spanning from the molecular to macroscopic level exemplified by studying such diverse areas as molecular networks and developmental processes the immune and nervous systems the heart cancer and multi organ failure The volume concludes with Part IV that addresses methods and techniques driven in design and development by this new understanding of biomedical science Key Topics Include Historic Perspectives of General Systems Thinking Fundamental Methods and Techniques for Studying Complex Dynamical Systems Applications from Molecular Networks to Disease Processes Enabling Technologies for Exploration of Systems in the Life Sciences Complex Systems Science in Biomedicine is essential reading for experimental theoretical and interdisciplinary scientists working in the biomedical research field interested in a comprehensive overview of thisrapidly emerging field About the Editors Thomas S Deisboeck is currently Assistant Professor of Radiology at Massachusetts General Hospital and Harvard Medical School in Boston An expert in interdisciplinary cancer modeling Dr Deisboeck is Director of the Complex Biosystems Modeling Laboratory which is part of the Harvard MIT Martinos Center for Biomedical Imaging J Yasha Kresh is currently Professor of Cardiothoracic Surgery and Research Director Professor of Medicine and Director of Cardiovascular Biophysics at the Drexel University College of Medicine An expert in dynamical systems he holds appointments in the School of Biomedical Engineering and Health Systems Dept of Mechanical Engineering and Molecular Pathobiology Program Prof Kresh is Fellow of the American College of Cardiology

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Correlated Random Systems: Five Different Methods Véronique Gayrard,Nicola Kistler,2015-06-09 This volume presents five different methods recently developed to tackle the large scale behavior of highly correlated random systems such as spin glasses random polymers local times and loop soups and random matrices These methods presented in a series of lectures delivered within the Jean Morlet initiative Spring 2013 play a fundamental role in the current development of probability theory and statistical mechanics The lectures were Random Polymers by E Bolthausen Spontaneous Replica Symmetry Breaking and Interpolation Methods by F Guerra Derrida s Random Energy Models by N Kistler Isomorphism Theorems by J Rosen and Spectral Properties of Wigner Matrices by B Schlein This book is the first in a co edition between the Jean Morlet Chair at CIRM and the Springer Lecture Notes in Mathematics which aims to collect together courses and lectures on cutting edge subjects given during the term of the Jean Morlet Chair as well as new material produced in its wake It is targeted at researchers in particular PhD students and postdocs working in probability theory and statistical physics

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