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The Random Projection Method

Santosh S. Vempala



American Mathematical Society

Random Projection Method

Yichuan Zhao, (Din) Ding-Geng Chen

A red circular graphic with a gradient, appearing as a stylized arrow or a partial circle, located to the right of the author names.

Random Projection Method:

The Random Projection Method Santosh S. Vempala, 2005-02-24 Random projection is a simple geometric technique for reducing the dimensionality of a set of points in Euclidean space while preserving pairwise distances approximately. The technique plays a key role in several breakthrough developments in the field of algorithms. In other cases it provides elegant alternative proofs. The book begins with an elementary description of the technique and its basic properties. Then it develops the method in the context of applications which are divided into three groups. The first group consists of combinatorial optimization problems such as maxcut, graph coloring, minimum multicut, graph bandwidth, and VLSI layout. Presented in this context is the theory of Euclidean embeddings of graphs. The next group is machine learning problems, specifically learning intersections of halfspaces and learning large margin hypotheses. The projection method is further refined for the latter application. The last set consists of problems inspired by information retrieval, namely nearest neighbor search, geometric clustering, and efficient low rank approximation. Motivated by the first two applications, an extension of random projection to the hypercube is developed here. Throughout the book, random projection is used as a way to understand, simplify, and connect progress on these important and seemingly unrelated problems. The book is suitable for graduate students and research mathematicians interested in computational geometry.

The Random Projection Method Santosh S. Vempala, *The Random Projection Method* Santosh Srinivas Vempala, 2004 Random projection is a simple geometric technique for reducing the dimensionality of a set of points in Euclidean space while preserving pairwise distances approximately. The technique plays a key role in several breakthrough developments in the field of algorithms. In other cases it provides elegant alternative proofs. The book begins with an elementary description of the technique and its basic properties. Then it develops the method in the context of applications which are divided into three groups. The first group consists of combinatorial optimization problems such as maxcut, graph coloring, minimum multicut, graph bandwidth, and VLSI layout. Presented in this context is the theory of Euclidean embeddings of graphs. The next group is machine learning problems, specifically learning intersections of halfspaces and learning large margin hypotheses. The projection method is further refined for the latter application. The last set consists of problems inspired by information retrieval, namely nearest neighbor search, geometric clustering, and efficient low rank approximation. Motivated by the first two applications, an extension of random projection to the hypercube is developed here. Throughout the book, random projection is used as a way to understand, simplify, and connect progress on these important and seemingly unrelated problems. The book is suitable for graduate students and research mathematicians interested in computational geometry.

Pattern Recognition Applications and Methods Maria De Marsico, Gabriella Sanniti di Baja, Ana Fred, 2018-06-15 This book contains revised and extended versions of selected papers from the 6th International Conference on Pattern Recognition ICPRAM 2017 held in Porto, Portugal, in February 2017. The 13 full papers presented were carefully reviewed and selected from 139 initial submissions. They aim at making visible and understandable the relevant trends of current research on pattern recognition.

Image and Signal Processing Alamin Mansouri, Abderrahim El Moataz, Fathallah Nouboud, Driss Mammass, 2018-06-29 This book constitutes the refereed proceedings of the 8th International Conference on Image and Signal Processing ICISP 2018 held in Cherbourg, France, in July 2018. The 58 revised full papers were carefully reviewed and selected from 122 submissions. The contributions report on the latest developments in image and signal processing, video processing, computer vision, multimedia, and computer graphics and mathematical imaging and vision.

Entropy Randomization in Machine Learning Yuri S. Popkov, Alexey Yu. Popkov, Yuri A. Dubnov, 2022-08-09 Entropy Randomization in Machine Learning presents a new approach to machine learning entropy.

randomization to obtain optimal solutions under uncertainty uncertain data and models of the objects under study

Randomized machine learning procedures involve models with random parameters and maximum entropy estimates of the probability density functions of the model parameters under balance conditions with measured data Optimality conditions are derived in the form of nonlinear equations with integral components A new numerical random search method is developed for solving these equations in a probabilistic sense Along with the theoretical foundations of randomized machine learning Entropy Randomization in Machine Learning considers several applications to binary classification modelling the dynamics of the Earth s population predicting seasonal electric load fluctuations of power supply systems and forecasting the thermokarst lakes area in Western Siberia Features A systematic presentation of the randomized machine learning problem from data processing through structuring randomized models and algorithmic procedure to the solution of applications relevant problems in different fields Provides new numerical methods for random global optimization and computation of multidimensional integrals A universal algorithm for randomized machine learning This book will appeal to undergraduates and postgraduates specializing in artificial intelligence and machine learning researchers and engineers involved in the development of applied machine learning systems and researchers of forecasting problems in various fields *Intelligent Software Methodologies, Tools and Techniques* Hamido Fujita, Guido Guizzi, 2015-08-31 This book constitutes the best papers selection from the proceedings of the 14th International Conference on Intelligent Software Methodologies Tools and Techniques SoMeT 2015 held in Naples Italy in September 2015 The 47 full papers presented together with one short paper were carefully reviewed and selected from 118 submissions The papers are organized in topical sections on embedded and mobile software systems theory and application real time systems requirement engineering high assurance and testing system social networks and big data cloud computing and semantic web artificial intelligence techniques and intelligent system design software development and integration security and software methodologies for reliable software design new software techniques in image processing and computer graphics software applications systems for medical health care

Hyperbolic Problems: Theory, Numerics, Applications Heinrich Freistühler, Gerald Warnecke, 2013-12-01 The Eighth International Conference on Hyperbolic Problems Theory Nu merics Applications was held in Magdeburg Germany from February 27 to March 3 2000 It was attended by over 220 participants from many European countries as well as Brazil Canada China Georgia India Israel Japan Taiwan und the USA There were 12 plenary lectures 22 further invited talks and around 150 con tributed talks in parallel sessions as well as posters The speakers in the parallel sessions were invited to provide a poster in order to enhance the dissemination of information Hyperbolic partial differential equations describe phenomena of material or wave transport in physics biology and engineering especially in the field of fluid mechanics Despite considerable progress the mathematical theory is still strug gling with fundamental open problems concerning systems of such equations in multiple space dimensions For various applications the development of accurate and efficient numerical

schemes for computation is of fundamental importance Applications touched in these proceedings concern one phase and multiphase fluid flow phase transitions shallow water dynamics elasticity extended thermodynamics electromagnetism classical and relativistic magnetohydrodynamics cosmology Contributions to the abstract theory of hyperbolic systems deal with viscous and relaxation approximations front tracking and wellposedness stability of shock profiles and multi shock patterns traveling fronts for transport equations Numerically oriented articles study finite difference finite volume and finite element schemes adaptive multiresolution and artificial dissipation methods

Experimental Study of Random Projections Below the JL Limit Xiuyi Ye (Software engineer), 2015 Random projection is a method used to reduce dimensionality of desired objects with pairwise distances preserved at a relatively high probability The mathematical theory behind this is called the Johnson Lindenstrauss JL lemma So the basic idea of the JL lemma is that a set of points in a high dimensional space p are randomly projected down to a lower dimensional space q This q can be as low as q_0 to still make sure that with a certain probability the projected pairwise distances are within plus minus epsilon of the pairwise distances before the projection where plus or minus epsilon is usually a very small value This technique has already been used in a variety of areas like clustering image and text data processing Lots of researchers have already studied the properties and performance of the JL lemma above q_0 q is usually called the JL limit or JL bound where $q \geq q_0$ but no research has investigated using the JL lemma below the JL limit $q < q_0$ With much lower dimension the data processing storing almost everything is going to be so much easier We can visualize the clustering information about data sets in 2D plots One thing should not be forgotten is that the distance preservation is probabilistic How well will the distances being preserved below the JL bound Will it affect or even completely destroy the cluster structure after the projection What is a good projection method We are going to study and answer these questions as much as we can in this thesis

Modern Statistical Methods for Health Research Yichuan Zhao, (Din) Ding-Geng Chen, 2021-10-14 This book brings together the voices of leading experts in the frontiers of biostatistics biomedicine and the health sciences to discuss the statistical procedures useful methods and novel applications in biostatistics research It also includes discussions of potential future directions of biomedicine and new statistical developments for health research with the intent of stimulating research and fostering the interactions of scholars across health research related disciplines Topics covered include Health data analysis and applications to EHR data Clinical trials FDR and applications in health science Big network analytics and its applications in GWAS Survival analysis and functional data analysis Graphical modelling in genomic studies The book will be valuable to data scientists and statisticians who are working in biomedicine and health other practitioners in the health sciences and graduate students and researchers in biostatistics and health

Learning Theory Gábor Lugosi, 2006-06-12 This book constitutes the refereed proceedings of the 19th Annual Conference on Learning Theory COLT 2006 held in Pittsburgh Pennsylvania USA in June 2006 The 43 revised full papers presented together with 2 articles on open problems and 3 invited

lectures were carefully reviewed and selected from a total of 102 submissions The papers cover a wide range of topics including clustering un and semisupervised learning statistical learning theory regularized learning and kernel methods query learning and teaching inductive inference learning algorithms and limitations on learning online aggregation online prediction and reinforcement learning

Geometric Structure of High-Dimensional Data and Dimensionality Reduction Jianzhong Wang,2012-04-28 Geometric Structure of High Dimensional Data and Dimensionality Reduction adopts data geometry as a framework to address various methods of dimensionality reduction In addition to the introduction to well known linear methods the book moreover stresses the recently developed nonlinear methods and introduces the applications of dimensionality reduction in many areas such as face recognition image segmentation data classification data visualization and hyperspectral imagery data analysis Numerous tables and graphs are included to illustrate the ideas effects and shortcomings of the methods MATLAB code of all dimensionality reduction algorithms is provided to aid the readers with the implementations on computers The book will be useful for mathematicians statisticians computer scientists and data analysts It is also a valuable handbook for other practitioners who have a basic background in mathematics statistics and or computer algorithms like internet search engine designers physicists geologists electronic engineers and economists Jianzhong Wang is a Professor of Mathematics at Sam Houston State University U S A

Handbook of Randomized Computing Sanguthevar Rajasekaran,2001

Machine Learning and Knowledge Discovery in Databases Walter Daelemans,Bart Goethals,2008-09-04 This book constitutes the refereed proceedings of the joint conference on Machine Learning and Knowledge Discovery in Databases ECML PKDD 2008 held in Antwerp Belgium in September 2008 The 100 papers presented in two volumes together with 5 invited talks were carefully reviewed and selected from 521 submissions In addition to the regular papers the volume contains 14 abstracts of papers appearing in full version in the Machine Learning Journal and the Knowledge Discovery and Databases Journal of Springer The conference intends to provide an international forum for the discussion of the latest high quality research results in all areas related to machine learning and knowledge discovery in databases The topics addressed are application of machine learning and data mining methods to real world problems particularly exploratory research that describes novel learning and mining tasks and applications requiring non standard techniques

Harmony Search and Nature Inspired Optimization Algorithms Neha Yadav,Anupam Yadav,Jagdish Chand Bansal,Kusum Deep,Joong Hoon Kim,2018-08-23 The book covers different aspects of real world applications of optimization algorithms It provides insights from the Fourth International Conference on Harmony Search Soft Computing and Applications held at BML Munjal University Gurgaon India on February 7 9 2018 It consists of research articles on novel and newly proposed optimization algorithms the theoretical study of nature inspired optimization algorithms numerically established results of nature inspired optimization algorithms and real world applications of optimization algorithms and synthetic benchmarking of optimization algorithms

Methods in Biomedical Informatics Indra Neil Sarkar,2013-09-03

Beginning with a survey of fundamental concepts associated with data integration knowledge representation and hypothesis generation from heterogeneous data sets *Methods in Biomedical Informatics* provides a practical survey of methodologies used in biological clinical and public health contexts These concepts provide the foundation for more advanced topics like information retrieval natural language processing Bayesian modeling and learning classifier systems The survey of topics then concludes with an exposition of essential methods associated with engineering personalized medicine and linking of genomic and clinical data Within an overall context of the scientific method *Methods in Biomedical Informatics* provides a practical coverage of topics that is specifically designed for 1 domain experts seeking an understanding of biomedical informatics approaches for addressing specific methodological needs or 2 biomedical informaticians seeking an approachable overview of methodologies that can be used in scenarios germane to biomedical research Contributors represent leading biomedical informatics experts individuals who have demonstrated effective use of biomedical informatics methodologies in the real world high quality biomedical applications Material is presented as a balance between foundational coverage of core topics in biomedical informatics with practical in the trenches scenarios Contains appendices that function as primers on 1 Unix 2 Ruby 3 Databases and 4 Web Services

Recent Developments in Machine Learning and Data Analytics Jugal Kalita,Valentina Emilia Balas,Samarjeet Borah,Ratika Pradhan,2018-09-11 This book presents high quality papers from an international forum for research on computational approaches to learning It includes current research and findings from various research labs universities and institutions that may lead to development of marketable products It also provides solid support for these findings in the form of empirical studies theoretical analysis or comparison to psychological phenomena Further it features work that shows how to apply learning methods to solve important application problems as well as how machine learning research is conducted The book is divided into two main parts Machine Learning Techniques which covers machine learning related research and findings and Data Analytics which introduces recent developments in this domain Additionally the book includes work on data analytics using machine learning techniques

Machine Learning and Knowledge Discovery in Databases Frank Hutter,Kristian Kersting,Jefrey Lijffijt,Isabel Valera,2021-02-24 The 5 volume proceedings LNAI 12457 until 12461 constitutes the refereed proceedings of the European Conference on Machine Learning and Knowledge Discovery in Databases ECML PKDD 2020 which was held during September 14 18 2020 The conference was planned to take place in Ghent Belgium but had to change to an online format due to the COVID 19 pandemic The 232 full papers and 10 demo papers presented in this volume were carefully reviewed and selected for inclusion in the proceedings The volumes are organized in topical sections as follows Part I Pattern Mining clustering privacy and fairness social network analysis and computational social science dimensionality reduction and autoencoders domain adaptation sketching sampling and binary projections graphical models and causality spatio temporal data and recurrent neural networks collaborative filtering and matrix completion Part II deep learning optimization and theory active learning adversarial learning federated

learning Kernel methods and online learning partial label learning reinforcement learning transfer and multi task learning
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2008: Theoretical Informatics Eduardo Sany Laber, 2008-03-17 This book constitutes the refereed proceedings of the 8th
 International Latin American Symposium on Theoretical Informatics LATIN 2008 held in B zios Brazil in April 2008 The 66
 revised full papers presented together with the extended abstract of 1 invited paper were carefully reviewed and selected
 from 242 submissions The papers address a variety of topics in theoretical computer science with a certain focus on
 algorithms automata theory and formal languages coding theory and data compression algorithmic graph theory and
 combinatorics complexity theory computational algebra computational biology computational geometry computational
 number theory cryptography theoretical aspects of databases and information retrieval data structures networks logic in
 computer science machine learning mathematical programming parallel and distributed computing pattern matching
 quantum computing and random structures *Advances in Biometrics* Massimo Tistarelli, Mark S. Nixon, 2009-06-04 rd It is
 a pleasure and an honour both to organize ICB 2009 the 3 IAPR IEEE Inter tional Conference on Biometrics This will be held
 2 5 June in Alghero Italy hosted by the Computer Vision Laboratory University of Sassari The conference series is the
 premier forum for presenting research in biometrics and its allied technologies the generation of new ideas new approaches
 new techniques and new evaluations The ICB series originated in 2006 from joining two highly reputed conferences Audio
 and Video Based Personal Authentication AVBPA and the International Conference on Biometric Authentication ICBA
 Previous conferences were held in Hong Kong and in Korea This is the first time the ICB conference has been held in Europe
 and by Programme Committee arrangements and by the quality of the papers ICB 2009 will continue to maintain the high
 standards set by its predecessors In total we received around 250 papers for review Of these 36 were selected for oral
 presentation and 93 for poster presentation These papers are accompanied by the invited speakers Heinrich H B lthoff Max
 Planck Institute for Biological Cybernetics T b gen Germany on What Can Machine Vision Learn from Human Perception
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