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# Algebraic Geometry And Statistical Learning Theory Cambridge Monographs On Applied And Computational Mathematics

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The Thermodynamics of Statistical Learning  
Statistical Learning with Sparsity  
Lectures on Algebraic Statistics  
How to Not Lie with Statistics  
Theory and Practice in Python  
From Theory to Algorithms  
A Theory Revolutionizing Technology and Science  
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Solving Systems of Polynomial Equations  
From Geometry, to Physics, to Machine Learning

Mathematics for Machine Learning  
The Lasso and Generalizations  
Elements of Causal Inference  
Understanding Machine Learning  
Foundations and Learning Algorithms

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## NEAL ANNA

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The Thermodynamics of  
Statistical Learning CRC  
Press

Discover New Methods for  
Dealing with High-  
Dimensional Data A  
sparse statistical model  
has only a small number  
of nonzero parameters or  
weights; therefore, it is  
much easier to estimate  
and interpret than a  
dense model. *Statistical  
Learning with Sparsity:  
The Lasso and  
Generalizations* presents  
methods that exploit  
sparsity to help recover  
the underlying signal in a  
set of data. Top experts in  
this rapidly evolving field,  
the authors describe the  
lasso for linear regression  
and a simple coordinate  
descent algorithm for its  
computation. They  
discuss the application of  
l1 penalties to generalized  
linear models and support  
vector machines, cover

generalized penalties  
such as the elastic net  
and group lasso, and  
review numerical methods  
for optimization. They also  
present statistical  
inference methods for  
fitted (lasso) models,  
including the bootstrap,  
Bayesian methods, and  
recently developed  
approaches. In addition,  
the book examines matrix  
decomposition, sparse  
multivariate analysis,  
graphical models, and  
compressed sensing. It  
concludes with a survey of  
theoretical results for the  
lasso. In this age of big  
data, the number of  
features measured on a  
person or object can be  
large and might be larger  
than the number of  
observations. This book  
shows how the sparsity  
assumption allows us to  
tackle these problems and  
extract useful and  
reproducible patterns  
from big datasets. Data  
analysts, computer  
scientists, and theorists  
will appreciate this  
thorough and up-to-date  
treatment of sparse  
statistical modeling.  
*Statistical Learning with  
Sparsity* Springer

This introduction to  
algebraic geometry allows  
readers to grasp the  
fundamentals of the  
subject with only linear  
algebra and calculus as  
prerequisites. After a brief  
history of the subject, the  
book introduces projective  
spaces and projective  
varieties, and explains  
plane curves and  
resolution of their  
singularities. The volume  
further develops the  
geometry of algebraic  
curves and treats  
congruence zeta functions  
of algebraic curves over a  
finite field. It concludes  
with a complex analytical  
discussion of algebraic  
curves. The author  
emphasizes computation  
of concrete examples  
rather than proofs, and  
these examples are  
discussed from various  
viewpoints. This approach  
allows readers to develop  
a deeper understanding of  
the theorems.

*Lectures on Algebraic  
Statistics Algebraic  
Geometry and Statistical  
Learning Theory*  
Tropical geometry is a  
combinatorial shadow of  
algebraic geometry,  
offering new polyhedral

tools to compute invariants of algebraic varieties. It is based on tropical algebra, where the sum of two numbers is their minimum and the product is their sum. This turns polynomials into piecewise-linear functions, and their zero sets into polyhedral complexes. These tropical varieties retain a surprising amount of information about their classical counterparts. Tropical geometry is a young subject that has undergone a rapid development since the beginning of the 21st century. While establishing itself as an area in its own right, deep connections have been made to many branches of pure and applied mathematics. This book offers a self-contained introduction to tropical geometry, suitable as a course text for beginning graduate students. Proofs are provided for the main results, such as the Fundamental Theorem and the Structure Theorem. Numerous examples and explicit computations illustrate the main concepts. Each of the six chapters concludes with problems that will help the readers to practice their tropical skills, and to gain access to the research literature.

This wonderful book will appeal to students and researchers of all stripes: it begins at an undergraduate level and ends with deep connections to toric varieties, compactifications, and degenerations. In between, the authors provide the first complete proofs in book form of many fundamental results in the subject. The pages are sprinkled with illuminating examples, applications, and exercises, and the writing is lucid and meticulous throughout. It is that rare kind of book which will be used equally as an introductory text by students and as a reference for experts. —Matt Baker, Georgia Institute of Technology  
Tropical geometry is an exciting new field, which requires tools from various parts of mathematics and has connections with many areas. A short definition is given by Maclagan and Sturmfels: “Tropical geometry is a marriage between algebraic and polyhedral geometry”. This wonderful book is a pleasant and rewarding journey through different landscapes, inviting the readers from a day at a beach to the hills of

modern algebraic geometry. The authors present building blocks, examples and exercises as well as recent results in tropical geometry, with ingredients from algebra, combinatorics, symbolic computation, polyhedral geometry and algebraic geometry. The volume will appeal both to beginning graduate students willing to enter the field and to researchers, including experts. —Alicia Dickenstein, University of Buenos Aires, Argentina  
**How to Not Lie with Statistics** Cambridge University Press  
This open access textbook provides the background needed to correctly use, interpret and understand statistics and statistical data in diverse settings. Part I makes key concepts in statistics readily clear. Parts I and II give an overview of the most common tests (t-test, ANOVA, correlations) and work out their statistical principles. Part III provides insight into meta-statistics (statistics of statistics) and demonstrates why experiments often do not replicate. Finally, the textbook shows how complex statistics can be avoided by using clever experimental design. Both non-scientists and students in Biology,

Biomedicine and Engineering will benefit from the book by learning the statistical basis of scientific claims and by discovering ways to evaluate the quality of scientific reports in academic journals and news outlets.

*Theory and Practice in Python* Addison-Wesley Professional

A comprehensive text on foundations and techniques of graph neural networks with applications in NLP, data mining, vision and healthcare.

*From Theory to Algorithms* Cambridge University Press

Algebraic geometry, central to pure mathematics, has important applications in such fields as engineering, computer science, statistics and computational biology, which exploit the computational algorithms that the theory provides. Users get the full benefit, however, when they know something of the underlying theory, as well as basic procedures and facts. This book is a systematic introduction to the central concepts of algebraic geometry most useful for computation. Written for advanced undergraduate and

graduate students in mathematics and researchers in application areas, it focuses on specific examples and restricts development of formalism to what is needed to address these examples. In particular, it introduces the notion of Gröbner bases early on and develops algorithms for almost everything covered. It is based on courses given over the past five years in a large interdisciplinary programme in computational algebraic geometry at Rice University, spanning mathematics, computer science, biomathematics and bioinformatics.

*A Theory Revolutionizing Technology and Science*  
American Mathematical Society

Can artificial intelligence learn mathematics? The question is at the heart of this original monograph bringing together theoretical physics, modern geometry, and data science. The study of Calabi–Yau manifolds lies at an exciting intersection between physics and mathematics. Recently, there has been much activity in applying machine learning to solve otherwise intractable problems, to conjecture new formulae, or to

understand the underlying structure of mathematics. In this book, insights from string and quantum field theory are combined with powerful techniques from complex and algebraic geometry, then translated into algorithms with the ultimate aim of deriving new information about Calabi–Yau manifolds. While the motivation comes from mathematical physics, the techniques are purely mathematical and the theme is that of explicit calculations. The reader is guided through the theory and provided with explicit computer code in standard software such as SageMath, Python and Mathematica to gain hands-on experience in applications of artificial intelligence to geometry. Driven by data and written in an informal style, *The Calabi–Yau Landscape* makes cutting-edge topics in mathematical physics, geometry and machine learning readily accessible to graduate students and beyond. The overriding ambition is to introduce some modern mathematics to the physicist, some modern physics to the mathematician, and machine learning to both. **3264 and All That** CRC Press

Table of contents  
*The Geometry of  
Multivariate Statistics* CRC  
Press

Linear algebra is something all undergraduates and many other students, in subjects ranging from engineering to economics, have to learn. The fifth edition of this hugely successful textbook retains all the qualities of earlier editions while at the same time seeing numerous minor improvements and major additions. The latter include:

- A new chapter on singular values and singular vectors, including ways to analyze a matrix of data
- A revised chapter on computing in linear algebra, with professional-level algorithms and code that can be downloaded for a variety of languages
- A new section on linear algebra and cryptography
- A new chapter on linear algebra in probability and statistics. A dedicated and active website also offers solutions to exercises as well as new exercises from many different sources (e.g. practice problems, exams, development of textbook examples), plus codes in MATLAB, Julia, and Python.

*Information Theory,*

*Inference and Learning Algorithms* Inst of Mathematical Statistic  
The Contemporary Introduction to Deep Reinforcement Learning that Combines Theory and Practice  
Deep reinforcement learning (deep RL) combines deep learning and reinforcement learning, in which artificial agents learn to solve sequential decision-making problems. In the past decade deep RL has achieved remarkable results on a range of problems, from single and multiplayer games—such as Go, Atari games, and DotA 2—to robotics.  
*Foundations of Deep Reinforcement Learning* is an introduction to deep RL that uniquely combines both theory and implementation. It starts with intuition, then carefully explains the theory of deep RL algorithms, discusses implementations in its companion software library SLM Lab, and finishes with the practical details of getting deep RL to work. This guide is ideal for both computer science students and software engineers who are familiar with basic machine learning concepts and have a working understanding of

Python. Understand each key aspect of a deep RL problem Explore policy- and value-based algorithms, including REINFORCE, SARSA, DQN, Double DQN, and Prioritized Experience Replay (PER) Delve into combined algorithms, including Actor-Critic and Proximal Policy Optimization (PPO) Understand how algorithms can be parallelized synchronously and asynchronously Run algorithms in SLM Lab and learn the practical implementation details for getting deep RL to work Explore algorithm benchmark results with tuned hyperparameters Understand how deep RL environments are designed Register your book for convenient access to downloads, updates, and/or corrections as they become available. See inside book for details.

**A Second Course in Algebraic Geometry**  
Cambridge University Press

This book, first published in 2005, offers an introduction to the application of algebraic statistics to computational biology.

[The Nature of Statistical Learning Theory](#) Machine Learning Mastery

Mathematical Theory of Bayesian Statistics introduces the mathematical foundation of Bayesian inference which is well-known to be more accurate in many real-world problems than the maximum likelihood method. Recent research has uncovered several mathematical laws in Bayesian statistics, by which both the generalization loss and the marginal likelihood are estimated even if the posterior distribution cannot be approximated by any normal distribution. Features Explains Bayesian inference not subjectively but objectively. Provides a mathematical framework for conventional Bayesian theorems. Introduces and proves new theorems. Cross validation and information criteria of Bayesian statistics are studied from the mathematical point of view. Illustrates applications to several statistical problems, for example, model selection, hyperparameter optimization, and hypothesis tests. This book provides basic introductions for students, researchers, and users of Bayesian statistics, as well as applied mathematicians. Author

Sumio Watanabe is a professor of Department of Mathematical and Computing Science at Tokyo Institute of Technology. He studies the relationship between algebraic geometry and mathematical statistics. *Geometry and Topology for Mesh Generation* CreateSpace This book can form the basis of a second course in algebraic geometry. As motivation, it takes concrete questions from enumerative geometry and intersection theory, and provides intuition and technique, so that the student develops the ability to solve geometric problems. The authors explain key ideas, including rational equivalence, Chow rings, Schubert calculus and Chern classes, and readers will appreciate the abundant examples, many provided as exercises with solutions available online. Intersection is concerned with the enumeration of solutions of systems of polynomial equations in several variables. It has been an active area of mathematics since the work of Leibniz. Chasles' nineteenth-century calculation that there are 3264 smooth conic plane curves tangent to five

given general conics was an important landmark, and was the inspiration behind the title of this book. Such computations were motivation for Poincaré's development of topology, and for many subsequent theories, so that intersection theory is now a central topic of modern mathematics. *Linear Algebra and Learning from Data* Springer Nature This book provides a comprehensive introduction to the latest advances in the mathematical theory and computational tools for modeling high-dimensional data drawn from one or multiple low-dimensional subspaces (or manifolds) and potentially corrupted by noise, gross errors, or outliers. This challenging task requires the development of new algebraic, geometric, statistical, and computational methods for efficient and robust estimation and segmentation of one or multiple subspaces. The book also presents interesting real-world applications of these new methods in image processing, image and video segmentation, face recognition and clustering, and hybrid system identification etc.

This book is intended to serve as a textbook for graduate students and beginning researchers in data science, machine learning, computer vision, image and signal processing, and systems theory. It contains ample illustrations, examples, and exercises and is made largely self-contained with three Appendices which survey basic concepts and principles from statistics, optimization, and algebraic-geometry used in this book. René Vidal is a Professor of Biomedical Engineering and Director of the Vision Dynamics and Learning Lab at The Johns Hopkins University. Yi Ma is Executive Dean and Professor at the School of Information Science and Technology at ShanghaiTech University. S. Shankar Sastry is Dean of the College of Engineering, Professor of Electrical Engineering and Computer Science and Professor of Bioengineering at the University of California, Berkeley.

### **Data Science for Mathematicians**

Cambridge University Press

This is a relatively fast paced graduate level introduction to complex

algebraic geometry, from the basics to the frontier of the subject. It covers sheaf theory, cohomology, some Hodge theory, as well as some of the more algebraic aspects of algebraic geometry. The author frequently refers the reader if the treatment of a certain topic is readily available elsewhere but goes into considerable detail on topics for which his treatment puts a twist or a more transparent viewpoint. His cases of exploration and are chosen very carefully and deliberately. The textbook achieves its purpose of taking new students of complex algebraic geometry through this a deep yet broad introduction to a vast subject, eventually bringing them to the forefront of the topic via a non-intimidating style.

### **Discover the Mathematical Language of Data in Python** Cambridge University Press

Linear algebra is a pillar of machine learning. You cannot develop a deep understanding and application of machine learning without it. In this laser-focused Ebook, you will finally cut through the equations, Greek letters, and confusion, and

discover the topics in linear algebra that you need to know. Using clear explanations, standard Python libraries, and step-by-step tutorial lessons, you will discover what linear algebra is, the importance of linear algebra to machine learning, vector, and matrix operations, matrix factorization, principal component analysis, and much more.

### Algebraic and Geometric Methods in Statistics

Routledge

Introduces machine learning and its algorithmic paradigms, explaining the principles behind automated learning approaches and the considerations underlying their usage.

### Basics of Linear Algebra for Machine Learning

Cambridge University Press

How does an algebraic geometer studying secant varieties further the understanding of hypothesis tests in statistics? Why would a statistician working on factor analysis raise open problems about determinantal varieties? Connections of this type are at the heart of the new field of "algebraic statistics". In this field, mathematicians and statisticians come

together to solve statistical inference problems using concepts from algebraic geometry as well as related computational and combinatorial techniques. The goal of these lectures is to introduce newcomers from the different camps to algebraic statistics. The introduction will be centered around the following three observations: many important statistical models correspond to algebraic or semi-algebraic sets of parameters; the geometry of these parameter spaces determines the behaviour of widely used statistical inference procedures; computational algebraic geometry can be used to study parameter spaces and other features of statistical models.

#### Methods of Information

#### Geometry Springer

Information geometry provides the mathematical sciences with a new framework of analysis. It has emerged from the investigation of the natural differential geometric structure on

manifolds of probability distributions, which consists of a Riemannian metric defined by the Fisher information and a one-parameter family of affine connections called the  $\alpha$ -connections. The duality between the  $\alpha$ -connection and the  $(-\alpha)$ -connection together with the metric play an essential role in this geometry. This kind of duality, having emerged from manifolds of probability distributions, is ubiquitous, appearing in a variety of problems which might have no explicit relation to probability theory. Through the duality, it is possible to analyze various fundamental problems in a unified perspective. The first half of this book is devoted to a comprehensive introduction to the mathematical foundation of information geometry, including preliminaries from differential geometry, the geometry of manifolds or probability distributions, and the general theory of dual affine connections. The second half of the text

provides an overview of many areas of applications, such as statistics, linear systems, information theory, quantum mechanics, convex analysis, neural networks, and affine differential geometry. The book can serve as a suitable text for a topics course for advanced undergraduates and graduate students.

#### **PAC-Bayesian Supervised**

**Classification** Princeton University Press

This book presents algorithmic tools for algebraic geometry, with experimental applications. It also introduces Macaulay 2, a computer algebra system supporting research in algebraic geometry, commutative algebra, and their applications. The algorithmic tools presented here are designed to serve readers wishing to bring such tools to bear on their own problems. The first part of the book covers Macaulay 2 using concrete applications; the second emphasizes details of the mathematics.

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