

Information Science and Statistics

John A. Lee · Michel Verleysen

# Nonlinear Dimensionality Reduction



Springer

# Nonlinear Dimensionality Reduction Information Science And Statistics

**Padhraic Smyth**

## **Nonlinear Dimensionality Reduction Information Science And Statistics:**

*Nonlinear Dimensionality Reduction* John A. Lee, Michel Verleysen, 2007-10-31 Methods of dimensionality reduction provide a way to understand and visualize the structure of complex data sets Traditional methods like principal component analysis and classical metric multidimensional scaling suffer from being based on linear models Until recently very few methods were able to reduce the data dimensionality in a nonlinear way However since the late nineties many new methods have been developed and nonlinear dimensionality reduction also called manifold learning has become a hot topic New advances that account for this rapid growth are e g the use of graphs to represent the manifold topology and the use of new metrics like the geodesic distance In addition new optimization schemes based on kernel techniques and spectral decomposition have lead to spectral embedding which encompasses many of the recently developed methods This book describes existing and advanced methods to reduce the dimensionality of numerical databases For each method the description starts from intuitive ideas develops the necessary mathematical details and ends by outlining the algorithmic implementation Methods are compared with each other with the help of different illustrative examples The purpose of the book is to summarize clear facts and ideas about well known methods as well as recent developments in the topic of nonlinear dimensionality reduction With this goal in mind methods are all described from a unifying point of view in order to highlight their respective strengths and shortcomings The book is primarily intended for statisticians computer scientists and data analysts It is also accessible to other practitioners having a basic background in statistics and or computational learning like psychologists in psychometry and economists

## **Engineering Applications of Neural Networks** Chrisina

Jayne, Shigang Yue, Lazaros S. Iliadis, 2013-04-19 This book constitutes the refereed proceedings of the 13th International Conference on Engineering Applications of Neural Networks EANN 2012 held in London UK in September 2012 The 49 revised full papers presented were carefully reviewed and selected from numerous submissions The papers describe the applications of neural networks and other computational intelligence approaches to intelligent transport environmental engineering computer security civil engineering financial forecasting virtual learning environments language interpretation bioinformatics and general engineering

## **Similarity-Based Clustering** Thomas Villmann, M. Biehl, Barbara Hammer, Michel

Verleysen, 2009-05-14 Similarity based learning methods have a great potential as an intuitive and exible toolbox for mining visualization and inspection of largedata sets They combine simple and human understandable principles such as distance based classi cation prototypes or Hebbian learning with a large variety of di erent problem adapted design choices such as a data optimum topology similarity measure or learning mode In medicine biology and medical bioinformatics more and more data arise from clinical measurements such as EEG or fMRI studies for monitoring brain activity mass spectrometry data for the detection of proteins peptides and composites or microarray pro les for the analysis of gene expressions Typically data are high dimensional noisy and very hard to inspect using classic e g symbolic or linear methods At the same time new

technologies ranging from the possibility of a very high resolution of spectra to high throughput screening for microarray data are rapidly developing and carry the promise of an efficient and automatic gathering of tons of high quality data with large information potential. Thus there is a need for appropriate machine learning methods which help to automatically extract and interpret the relevant parts of this information and which eventually help to enable understanding of biological systems, reliable diagnosis of faults and therapy of diseases such as cancer based on this information. Moreover these application scenarios pose fundamental and qualitatively new challenges to the learning systems, because of the specifics of the data and learning tasks. Since these characteristics are particularly pronounced within the medical domain but not limited to it and of principled interest this research topic opens the way toward important new directions of algorithmic design and accompanying theory.

**Machine Learning and Data Mining in Pattern Recognition** Petra Perner, Azriel Rosenfeld, 2003-08-02 The International Conference on Machine Learning and Data Mining (MLDM) is the third meeting in a series of biennial events which started in 1999 organized by the Institute of Computer Vision and Applied Computer Sciences (IBAI) in Leipzig. MLDM began as a workshop and is now a conference and has brought the topic of machine learning and data mining to the attention of the research community. Seventy-five papers were submitted to the conference this year. The program committee worked hard to select the most progressive research in a fair and competent review process which led to the acceptance of 33 papers for presentation at the conference. The 33 papers in these proceedings cover a wide variety of topics related to machine learning and data mining. The two invited talks deal with learning in case based reasoning and with mining for structural data. The contributed papers can be grouped into nine areas: support vector machines, pattern classification, decision trees, clustering, classification and retrieval, case based reasoning, Bayesian models and methods, association rules and applications. We would like to express our appreciation to the reviewers for their precise and highly professional work. We are grateful to the German Science Foundation for its support of the Eastern European researchers. We appreciate the help and understanding of the editorial staff at Springer Verlag and in particular Alfred Hofmann.

who supported the publication of these proceedings in the LNAI series. Last but not least we wish to thank all the speakers and participants who contributed to the success of the conference.

**Feature Fusion for Next-Generation AI** Anindya Nag, Md. Mehedi Hassan, Anupam Kumar Bairagi, 2025-10-10 This book delves into the fundamental concepts, methodologies, and practical implementations of feature fusion, providing valuable perspectives on how merging several data aspects might augment the decision making skills of artificial intelligence. Feature fusion is inherently connected to the advancement of intelligent solutions from medical data as it enables the incorporation of various and complementary data sources to construct more advanced AI models. Within the medical domain, data manifests in diverse formats including electronic health records (EHRs), medical imaging, genomic data, and real-time sensor metrics. Although each of these data kinds offers distinct perspectives, they may have limitations in terms of their breadth or depth when considered independently. The application of

feature fusion enables the integration of diverse data sources into a unified model hence improving the AI's capacity to detect patterns, make precise predictions and produce significant insights. The fusion process facilitates the development of intelligent solutions that exhibit enhanced reliability and effectiveness by using a more extensive reservoir of knowledge. For example, an artificial intelligence system that combines imaging data with clinical history might enhance the precision of disease diagnosis, forecast patient outcomes and suggest tailored treatment strategies. Feature fusion is the crucial factor in unleashing the complete capabilities of medical data, enabling artificial intelligence to provide intelligent solutions that not only enhance the provision of healthcare but also stimulate advancements in medical research and practice. The proposed book explores the advanced notion of feature fusion within the field of artificial intelligence with a particular emphasis on its implementation in physiological data. The integration of many data sources is crucial in the development of more precise, dependable and understandable AI models as the healthcare industry becomes more data driven.

Applied Science, Materials Science and Information Technologies in Industry D.L. Liu, X.B. Zhu, K.L. Xu, D.M. Fang, 2014-02-06 Selected peer reviewed papers from the 2014 International Conference on Advances in Materials Science and Information Technologies in Industry AMSITI 2014 January 11-12 2014 Xi'an China

### **Elements of Dimensionality Reduction and Manifold**

**Learning** Benyamin Ghojogh, Mark Crowley, Fakhri Karray, Ali Ghodsi, 2023-02-02 Dimensionality reduction, also known as manifold learning, is an area of machine learning used for extracting informative features from data for better representation of data or separation between classes. This book presents a cohesive review of linear and nonlinear dimensionality reduction and manifold learning. Three main aspects of dimensionality reduction are covered: spectral dimensionality reduction, probabilistic dimensionality reduction, and neural network based dimensionality reduction, which have geometric, probabilistic, and information theoretic points of view to dimensionality reduction, respectively. The necessary background and preliminaries on linear algebra, optimization, and kernels are also explained to ensure a comprehensive understanding of the algorithms. The tools introduced in this book can be applied to various applications involving feature extraction, image processing, computer vision, and signal processing. This book is applicable to a wide audience who would like to acquire a deep understanding of the various ways to extract, transform, and understand the structure of data. The intended audiences are academics, students, and industry professionals. Academic researchers and students can use this book as a textbook for machine learning and dimensionality reduction. Data scientists, machine learning scientists, computer vision scientists, and computer scientists can use this book as a reference. It can also be helpful to statisticians in the field of statistical learning and applied mathematicians in the fields of manifolds and subspace analysis. Industry professionals, including applied engineers, data engineers, and engineers in various fields of science dealing with machine learning, can use this as a guidebook for feature extraction from their data as the raw data in industry often require preprocessing. The book is grounded in theory but provides thorough explanations and diverse examples to improve the reader's comprehension of the

advanced topics Advanced methods are explained in a step by step manner so that readers of all levels can follow the reasoning and come to a deep understanding of the concepts This book does not assume advanced theoretical background in machine learning and provides necessary background although an undergraduate level background in linear algebra and calculus is recommended [Mathematical Reviews](#) ,2008 [Nonlinear Dimensionality Reduction Techniques](#) Sylvain Lespinats,Benoit Colange,Denys Dutykh,2021-12-02 This book proposes tools for analysis of multidimensional and metric data by establishing a state of the art of the existing solutions and developing new ones It mainly focuses on visual exploration of these data by a human analyst relying on a 2D or 3D scatter plot display obtained through Dimensionality Reduction Performing diagnosis of an energy system requires identifying relations between observed monitoring variables and the associated internal state of the system Dimensionality reduction which allows to represent visually a multidimensional dataset constitutes a promising tool to help domain experts to analyse these relations This book reviews existing techniques for visual data exploration and dimensionality reduction such as tSNE and Isomap and proposes new solutions to challenges in that field In particular it presents the new unsupervised technique ASKI and the supervised methods ClassNeRV and ClassJSE Moreover MING a new approach for local map quality evaluation is also introduced These methods are then applied to the representation of expert designed fault indicators for smart buildings I V curves for photovoltaic systems and acoustic signals for Li ion batteries [Data Fusion and Data Mining for Power System Monitoring](#) Arturo Román Messina,2020-05-05 Data Fusion and Data Mining for Power System Monitoring provides a comprehensive treatment of advanced data fusion and data mining techniques for power system monitoring with focus on use of synchronized phasor networks Relevant statistical data mining techniques are given and efficient methods to cluster and visualize data collected from multiple sensors are discussed Both linear and nonlinear data driven mining and fusion techniques are reviewed with emphasis on the analysis and visualization of massive distributed data sets Challenges involved in realistic monitoring visualization and analysis of observation data from actual events are also emphasized supported by examples of relevant applications Features Focuses on systematic illustration of data mining and fusion in power systems Covers issues of standards used in the power industry for data mining and data analytics Applications to a wide range of power networks are provided including distribution and transmission networks Provides holistic approach to the problem of data mining and data fusion using cutting edge methodologies and technologies Includes applications to massive spatiotemporal data from simulations and actual events [Nonlinear Dimensionality Reduction with Side Information](#) Ali Ghodsi,2006 [E-Systems for the 21st Century](#) Seifedine Kadry,Abdelkhalak El Hami,2019-07-10 E based systems and computer networks are becoming standard practice across all sectors including health engineering business education security and citizen interaction with local and national government With contributions from researchers and practitioners from around the world this two volume book discusses and reports on new and important developments in the field of e

systems covering a wide range of current issues in the design engineering and adoption of e systems      **Advanced Lectures on Machine Learning** ,2003      *Advances in Mechatronics, Robotics and Automation II* Prasad Yarlagadda,2014-04-04 Selected peer reviewed papers from the 2014 2nd International Conference on Mechatronics Robotics and Automation ICMRA 2014 March 8 9 2014 Zhuhai China      Proceedings of the Seventh SIAM International Conference on Data Mining Chid Apte,Bing Liu,Srinivasan Parthasarathy,2007 The Seventh SIAM International Conference on Data Mining SDM 2007 continues a series of conferences whose focus is the theory and application of data mining to complex datasets in science engineering biomedicine and the social sciences These datasets challenge our abilities to analyze them because they are large and often noisy Sophisticated highperformance and principled analysis techniques and algorithms based on sound statistical foundations are required Visualization is often critically important tuning for performance is a significant challenge and the appropriate levels of abstraction to allow end users to exploit sophisticated techniques and understand clearly both the constraints and interpretation of results are still something of an open question

Annual Review of Information Science and Technology (arist) Information Today, Inc,2003 Since 1966 ARIST has been continuously at the cutting edge in contributing a useful and comprehensive view of the broad field of information science and technology ARIST reviews numerous topics within the field and ultimately provides this annual source of ideas trends and references to the literature The series encompasses the entire field in all its aspects and topics for the annual volume are selected on the basis of timeliness and an assessment of reader interest      Measuring Technology and Mechatronics Automation Zhixiang Hou,2011-02-02 Selected peer reviewed papers from the Third International Conference on Measuring Technology and Mechatronics Automation ICMTMA held in Shanghai China Jan 6 7 2011      *Journal of Machine Learning Research* ,2007 An international forum covering all areas of machine learning      *SIAM Journal on Scientific Computing* ,2009      **Principal Manifolds for Data Visualization and Dimension Reduction** Alexander N. Gorban,Balázs Kégl,Donald C. Wunsch,Andrei Zinovyev,2007-09-11 In 1901 Karl Pearson invented Principal Component Analysis PCA Since then PCA serves as a prototype for many other tools of data analysis visualization and dimension reduction Independent Component Analysis ICA Multidimensional Scaling MDS Nonlinear PCA NLPCA Self Organizing Maps SOM etc The book starts with the quote of the classical Pearson definition of PCA and includes reviews of various methods NLPCA ICA MDS embedding and clustering algorithms principal manifolds and SOM New approaches to NLPCA principal manifolds branching principal components and topology preserving mappings are described as well Presentation of algorithms is supplemented by case studies from engineering to astronomy but mostly of biological data analysis of microarray and metabolite data The volume ends with a tutorial PCA and K means decipher genome The book is meant to be useful for practitioners in applied data analysis in life sciences engineering physics and chemistry it will also be valuable to PhD students and researchers in computer sciences applied mathematics and statistics

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