

THE IMA VOLUMES IN MATHEMATICS  
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# **Mathematical Foundations of Speech and Language Processing**



Springer

# Mathematical Foundations Of Speech And Language Processing

**Joseph Keshet, Samy Bengio**



## **Mathematical Foundations Of Speech And Language Processing:**

*Mathematical Foundations of Speech and Language Processing* Mark Johnson, Sanjeev P. Khudanpur, Mari Ostendorf, Roni Rosenfeld, 2004-03-18 Speech and language technologies continue to grow in importance as they are used to create natural and efficient interfaces between people and machines and to automatically transcribe extract analyze and route information from high volume streams of spoken and written information The workshops on Mathematical Foundations of Speech Processing and Natural Language Modeling were held in the Fall of 2000 at the University of Minnesota's NSF sponsored Institute for Mathematics and Its Applications as part of a Mathematics in Multimedia year long program Each workshop brought together researchers in the respective technologies on the one hand and mathematicians and statisticians on the other hand for an intensive week of cross fertilization There is a long history of benefit from introducing mathematical techniques and ideas to speech and language technologies Examples include the source channel paradigm hidden Markov models decision trees exponential models and formal languages theory It is likely that new mathematical techniques or novel applications of existing techniques will once again prove pivotal for moving the field forward This volume consists of original contributions presented by participants during the two workshops Topics include language modeling prosody acoustic phonetic modeling and statistical methodology

### **Mathematical Foundations of Speech and Language Processing**

Mark Johnson, Sanjeev P. Khudanpur, Mari Ostendorf, Roni Rosenfeld, 2012-12-06 Speech and language technologies continue to grow in importance as they are used to create natural and efficient interfaces between people and machines and to automatically transcribe extract analyze and route information from high volume streams of spoken and written information The workshops on Mathematical Foundations of Speech Processing and Natural Language Modeling were held in the Fall of 2000 at the University of Minnesota's NSF sponsored Institute for Mathematics and Its Applications as part of a Mathematics in Multimedia year long program Each workshop brought together researchers in the respective technologies on the one hand and mathematicians and statisticians on the other hand for an intensive week of cross fertilization There is a long history of benefit from introducing mathematical techniques and ideas to speech and language technologies Examples include the source channel paradigm hidden Markov models decision trees exponential models and formal languages theory It is likely that new mathematical techniques or novel applications of existing techniques will once again prove pivotal for moving the field forward This volume consists of original contributions presented by participants during the two workshops Topics include language modeling prosody acoustic phonetic modeling and statistical methodology

**Handbook of Signal Processing in Acoustics** David Havelock, 2008

[Automatic Speech and Speaker Recognition](#) Joseph Keshet, Samy

Bengio, 2009-04-27 This book discusses large margin and kernel methods for speech and speaker recognition Speech and Speaker Recognition Large Margin and Kernel Methods is a collation of research in the recent advances in large margin and kernel methods as applied to the field of speech and speaker recognition It presents theoretical and practical foundations of

these methods from support vector machines to large margin methods for structured learning It also provides examples of large margin based acoustic modelling for continuous speech recognizers where the grounds for practical large margin sequence learning are set Large margin methods for discriminative language modelling and text independent speaker verification are also addressed in this book Key Features Provides an up to date snapshot of the current state of research in this field Covers important aspects of extending the binary support vector machine to speech and speaker recognition applications Discusses large margin and kernel method algorithms for sequence prediction required for acoustic modeling Reviews past and present work on discriminative training of language models and describes different large margin algorithms for the application of part of speech tagging Surveys recent work on the use of kernel approaches to text independent speaker verification and introduces the main concepts and algorithms Surveys recent work on kernel approaches to learning a similarity matrix from data This book will be of interest to researchers practitioners engineers and scientists in speech processing and machine learning fields

**Deep Learning for NLP and Speech Recognition** Uday Kamath, John Liu, James Whitaker, 2019-06-10 This textbook explains Deep Learning Architecture with applications to various NLP Tasks including Document Classification Machine Translation Language Modeling and Speech Recognition With the widespread adoption of deep learning natural language processing NLP and speech applications in many areas including Finance Healthcare and Government there is a growing need for one comprehensive resource that maps deep learning techniques to NLP and speech and provides insights into using the tools and libraries for real world applications Deep Learning for NLP and Speech Recognition explains recent deep learning methods applicable to NLP and speech provides state of the art approaches and offers real world case studies with code to provide hands on experience Many books focus on deep learning theory or deep learning for NLP specific tasks while others are cookbooks for tools and libraries but the constant flux of new algorithms tools frameworks and libraries in a rapidly evolving landscape means that there are few available texts that offer the material in this book The book is organized into three parts aligning to different groups of readers and their expertise The three parts are Machine Learning NLP and Speech Introduction The first part has three chapters that introduce readers to the fields of NLP speech recognition deep learning and machine learning with basic theory and hands on case studies using Python based tools and libraries Deep Learning Basics The five chapters in the second part introduce deep learning and various topics that are crucial for speech and text processing including word embeddings convolutional neural networks recurrent neural networks and speech recognition basics Theory practical tips state of the art methods experimentations and analysis in using the methods discussed in theory on real world tasks Advanced Deep Learning Techniques for Text and Speech The third part has five chapters that discuss the latest and cutting edge research in the areas of deep learning that intersect with NLP and speech Topics including attention mechanisms memory augmented networks transfer learning multi task learning domain adaptation reinforcement learning and end to end deep learning for

speech recognition are covered using case studies      *Speech and Audio Processing for Coding, Enhancement and Recognition* Tokunbo Ogunfunmi, Roberto Togneri, Madihally (Sim) Narasimha, 2014-10-14 This book describes the basic principles underlying the generation coding transmission and enhancement of speech and audio signals including advanced statistical and machine learning techniques for speech and speaker recognition with an overview of the key innovations in these areas Key research undertaken in speech coding speech enhancement speech recognition emotion recognition and speaker diarization are also presented along with recent advances and new paradigms in these areas      Log-Linear Models, Extensions, and Applications Aleksandr Aravkin, Anna Choromanska, Li Deng, Georg Heigold, Tony Jebara, 2024-12-03 Advances in training models with log linear structures with topics including variable selection the geometry of neural nets and applications Log linear models play a key role in modern big data and machine learning applications From simple binary classification models through partition functions conditional random fields and neural nets log linear structure is closely related to performance in certain applications and influences fitting techniques used to train models This volume covers recent advances in training models with log linear structures covering the underlying geometry optimization techniques and multiple applications The first chapter shows readers the inner workings of machine learning providing insights into the geometry of log linear and neural net models The other chapters range from introductory material to optimization techniques to involved use cases The book which grew out of a NIPS workshop is suitable for graduate students doing research in machine learning in particular deep learning variable selection and applications to speech recognition The contributors come from academia and industry allowing readers to view the field from both perspectives Contributors Aleksandr Aravkin Avishy Carmi Guillermo A Cecchi Anna Choromanska Li Deng Xinwei Deng Jean Honorio Tony Jebara Huijing Jiang Dimitri Kanevsky Brian Kingsbury Fabrice Lambert Aur lie C Lozano Daniel Moskovich Yuriy S Polyakov Bhuvana Ramabhadran Irina Rish Dimitris Samaras Tara N Sainath Hagen Soltau Serge F Timashev Ewout van den Berg      **Multimodal Agents for Ageing and Multicultural Societies** Juliana Miehle, Wolfgang Minker, Elisabeth André, Koichiro Yoshino, 2021-10-09 This book aims to explore and discuss theories and technologies for the development of socially competent and culture aware embodied conversational agents for elderly care To tackle the challenges in ageing societies this book was written by experts who have a background in assistive technologies for elderly care culture aware computing multimodal dialogue social robotics and synthetic agents Chapter 1 presents a vision of an intelligent agent to illustrate the current challenges for the design and development of adaptive systems Chapter 2 examines how notions of trust and empathy may be applied to human robot interaction and how it can be used to create the next generation of emphatic agents which address some of the pressing issues in multicultural ageing societies Chapter 3 discusses multimodal machine learning as an approach to enable more effective and robust modelling technologies and to develop socially competent and culture aware embodied conversational agents for elderly care Chapter 4 explores the challenges associated with real world field tests and deployments Chapter 5

gives a short introduction to socio cognitive language processing that describes the idea of coping with everyday language irony sarcasm humor paralinguistic information such as the physical and mental state and traits of the dialogue partner and social aspects This book grew out of the Shonan Meeting seminar entitled Multimodal Agents for Ageing and Multicultural Societies held in 2018 in Japan Researchers and practitioners will be helped to understand the emerging field and the identification of promising approaches from a variety of disciplines such as human computer interaction artificial intelligence modelling and learning

Computer Vision - ACCV 2014 Workshops C.V. Jawahar, Shiguang Shan, 2015-04-10 The three volume set consisting of LNCS 9008 9009 and 9010 contains carefully reviewed and selected papers presented at 15 workshops held in conjunction with the 12th Asian Conference on Computer Vision ACCV 2014 in Singapore in November 2014 The 153 full papers presented were selected from numerous submissions LNCS 9008 contains the papers selected for the Workshop on Human Gait and Action Analysis in the Wild the Second International Workshop on Big Data in 3D Computer Vision the Workshop on Deep Learning on Visual Data the Workshop on Scene Understanding for Autonomous Systems and the Workshop on Robust Local Descriptors for Computer Vision LNCS 9009 contains the papers selected for the Workshop on Emerging Topics on Image Restoration and Enhancement the First International Workshop on Robust Reading the Second Workshop on User Centred Computer Vision the International Workshop on Video Segmentation in Computer Vision the Workshop My Car Has Eyes Intelligent Vehicle with Vision Technology the Third Workshop on E Heritage and the Workshop on Computer Vision for Affective Computing LNCS 9010 contains the papers selected for the Workshop on Feature and Similarity for Computer Vision the Third International Workshop on Intelligent Mobile and Egocentric Vision and the Workshop on Human Identification for Surveillance

**Latent Semantic Mapping** Jerome R. Bellegarda, 2022-05-31 Latent semantic mapping LSM is a generalization of latent semantic analysis LSA a paradigm originally developed to capture hidden word patterns in a text document corpus In information retrieval LSA enables retrieval on the basis of conceptual content instead of merely matching words between queries and documents It operates under the assumption that there is some latent semantic structure in the data which is partially obscured by the randomness of word choice with respect to retrieval Algebraic and or statistical techniques are brought to bear to estimate this structure and get rid of the obscuring noise This results in a parsimonious continuous parameter description of words and documents which then replaces the original parameterization in indexing and retrieval This approach exhibits three main characteristics Discrete entities words and documents are mapped onto a continuous vector space This mapping is determined by global correlation patterns and Dimensionality reduction is an integral part of the process Such fairly generic properties are advantageous in a variety of different contexts which motivates a broader interpretation of the underlying paradigm The outcome LSM is a data driven framework for modeling meaningful global relationships implicit in large volumes of not necessarily textual data This monograph gives a general overview of the framework and underscores the multifaceted benefits it can bring to a number of

problems in natural language understanding and spoken language processing It concludes with a discussion of the inherent tradeoffs associated with the approach and some perspectives on its general applicability to data driven information extraction Contents I Principles Introduction Latent Semantic Mapping LSM Feature Space Computational Effort Probabilistic Extensions II Applications Junk E mail Filtering Semantic Classification Language Modeling Pronunciation Modeling Speaker Verification TTS Unit Selection III Perspectives Discussion Conclusion Bibliography     **Mobile Speech and Advanced Natural Language Solutions** Amy Neustein, Judith A. Markowitz, 2013-02-03 Mobile Speech and Advanced Natural Language Solutions presents the discussion of the most recent advances in intelligent human computer interaction including fascinating new study findings on talk in interaction which is the province of conversation analysis a subfield in sociology sociolinguistics a new and emerging area in natural language understanding Editors Amy Neustein and Judith A Markowitz have recruited a talented group of contributors to introduce the next generation natural language technologies for practical speech processing applications that serve the consumer s need for well functioning natural language driven personal assistants and other mobile devices while also addressing business need for better functioning IVR driven call centers that yield a more satisfying experience for the caller This anthology is aimed at two distinct audiences one consisting of speech engineers and system developers the other comprised of linguists and cognitive scientists The text builds on the experience and knowledge of each of these audiences by exposing them to the work of the other     *Nonlinear Dynamics of Electronic Systems* Valeri M. Mladenov, Plamen Ch. Ivanov, 2014-06-30 This book constitutes the refereed proceedings of the 22nd International Conference on Nonlinear Dynamics of Electronic Systems NDES 2014 held in Albena Bulgaria in July 2014 The 47 revised full papers presented were carefully reviewed and selected from 65 submissions The papers are organized in topical sections on nonlinear oscillators circuits and electronic systems networks and nonlinear dynamics and nonlinear phenomena in biological and physiological systems     Automatic Assessment of Prosody in Second Language Learning Florian Hönig, 2017 Worldwide there is a universal need for second language language learning It is obvious that the computer can be a great help for this especially when equipped with methods for automatically assessing the learner s pronunciation While assessment of segmental pronunciation quality i e whether phones and words are pronounced correctly or not is already available in commercial software packages prosody i e rhythm word accent etc is largely ignored although it highly impacts intelligibility and listening effort The present thesis contributes to closing this gap by developing and analyzing methods for automatically assessing the prosody of non native speakers We study the detection of word accent errors and the general assessment of the appropriateness of a speaker s rhythm We propose a flexible generic approach that is a very successful on these tasks b competitive to other state of the art result and at the same time c flexible and easily adapted to new tasks     *Mixed Integer Nonlinear Programming* Jon Lee, Sven Leyffer, 2011-12-02 Many engineering operations and scientific applications include a mixture of discrete and continuous decision variables and nonlinear

relationships involving the decision variables that have a pronounced effect on the set of feasible and optimal solutions Mixed integer nonlinear programming MINLP problems combine the numerical difficulties of handling nonlinear functions with the challenge of optimizing in the context of nonconvex functions and discrete variables MINLP is one of the most flexible modeling paradigms available for optimization but because its scope is so broad in the most general cases it is hopelessly intractable Nonetheless an expanding body of researchers and practitioners including chemical engineers operations researchers industrial engineers mechanical engineers economists statisticians computer scientists operations managers and mathematical programmers are interested in solving large scale MINLP instances

*Grammatical Inference for Computational Linguistics* Jeffrey Heinz, Colin de la Higuera, Menno van Zaanen, 2015-10-01 This book provides a thorough introduction to the subfield of theoretical computer science known as grammatical inference from a computational linguistic perspective Grammatical inference provides principled methods for developing computationally sound algorithms that learn structure from strings of symbols The relationship to computational linguistics is natural because many research problems in computational linguistics are learning problems on words phrases and sentences What algorithm can take as input some finite amount of data for instance a corpus annotated or otherwise and output a system that behaves correctly on specific tasks Throughout the text the key concepts of grammatical inference are interleaved with illustrative examples drawn from problems in computational linguistics Special attention is paid to the notion of learning bias In the context of computational linguistics such bias can be thought to reflect common ideally universal properties of natural languages This bias can be incorporated either by identifying a learnable class of languages which contains the language to be learned or by using particular strategies for optimizing parameter values Examples are drawn largely from two linguistic domains phonology and syntax which span major regions of the Chomsky Hierarchy from regular to context sensitive classes The conclusion summarizes the major lessons and open questions that grammatical inference brings to computational linguistics

Simultaneous Structure in Phonology D. Robert Ladd, 2014-04-03 In this book D Robert Ladd focuses on problems with the one dimensional idealization of language on which much linguistic theory is based Strings of sequentially ordered elements play an important role as theoretical abstractions in both phonology and syntax Yet many well known phonological phenomena such as vowel harmony ablaut morphology and pitch features are problematic for this one dimensional idealization and many attempts such as autosegmental phonology have been made to allow for these troublesome characteristics in our theories The book deals with diverse aspects of these problematical non sequential phenomena The five main chapters cover distinctive features and autosegments systematic phonetics the definition of prosody aspects of vocal paralinguistic communication and gradience and duality of patterning Each chapter reviews a wide range of relevant literature generally going back to the beginnings of modern linguistics in the early twentieth century and all of them can usefully be read as free standing synthetic overviews of the issues they discuss The final chapter suggests that phonological



structure sequential or otherwise can be seen as a special case of the segmentation of continuous action into discrete events and that research on this general topic within cognitive psychology is relevant to phonological theory Professor Ladd's unique work makes a fundamental contribution to phonology and phonetics and to linguistic theory more generally His book will interest all theoretical linguists and cognitive scientists concerned with understanding the relation between phonological representations and the speech signal

### **Dependability in Sensor, Cloud, and Big Data Systems and Applications**

Guojun Wang, Md Zakirul Alam Bhuiyan, Sabrina De Capitani di Vimercati, Yizhi Ren, 2019-11-05 This book constitutes the refereed proceedings of the 5th International Conference on Dependability in Sensor Cloud and Big Data Systems and Applications DependSys held in Guangzhou China in November 2019 The volume presents 39 full papers which were carefully reviewed and selected from 112 submissions The papers are organized in topical sections on dependability and security fundamentals and technologies dependable and secure systems dependable and secure applications dependability and security measures and assessments explainable artificial intelligence for cyberspace

*Social Intelligence* Dong Wang, Lanyu Shang, Yang Zhang, 2025-07-07 Given the rise of AI and the advent of online collaboration opportunities e.g. social media crowdsourcing emerging research has started to investigate the integration of AI and human intelligence especially in a collaborative social context This creates unprecedented challenges and opportunities in the field of Social Intelligence SI where the goal is to explore the collective intelligence of both humans and machines by understanding their complementary strengths and interactions in the social space In this book a set of novel human centered AI techniques are presented to address the challenges of social intelligence applications including multimodal approaches robust and generalizable frameworks and socially empowered explainable AI designs The book then presents several human AI collaborative learning frameworks that jointly integrate the strengths of crowd wisdom and AI to address the limitations inherent in standalone solutions The book also emphasizes pressing societal issues in the realm of social intelligence such as fairness bias and privacy Real world case studies from different applications in social intelligence are presented to demonstrate the effectiveness of the proposed solutions in achieving substantial performance gains in various aspects such as prediction accuracy model generalizability and explainability algorithmic fairness and system robustness

*The Probabilistic Mind* Nick Chater, Mike Oaksford, 2008 The Probabilistic Mind is a follow up to the influential and highly cited Rational Models of Cognition OUP 1998 It brings together developments in understanding how and how far high level cognitive processes can be understood in rational terms and particularly using probabilistic Bayesian methods

Handbook of Pattern Recognition and Computer Vision (5th Edition) Chi-hau Chen, 2015-12-15 The book provides an up to date and authoritative treatment of pattern recognition and computer vision with chapters written by leaders in the field On the basic methods in pattern recognition and computer vision topics range from statistical pattern recognition to array grammars to projective geometry to skeletonization and shape and texture measures Recognition applications include character

recognition and document analysis detection of digital mammograms remote sensing image fusion and analysis of functional magnetic resonance imaging data etc

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