Blind Speech Separation

Blind Speech Separation Blind Speech Separation Untangling the Threads of Sound Blind Source Separation Speech Separation Cocktail Party Problem Machine Learning Deep Learning NonNegative Matrix Factorization Independent Component Analysis Ethical Considerations Privacy Bias Blind speech separation BSS aims to disentangle multiple simultaneous speech signals a task akin to understanding individual conversations at a bustling cocktail party This challenging problem has garnered significant attention due to its potential applications in various fields including telecommunications assistive listening devices and meeting transcription This blog post delves into the intricacies of BSS exploring its underlying principles analyzing current trends and discussing crucial ethical considerations Imagine being at a noisy party with multiple conversations happening simultaneously Its a cacophony of voices laughter and clinking glasses Yet somehow our brains manage to focus on a single speaker filtering out the background noise This remarkable ability known as cocktail party effect has long fascinated scientists and engineers Blind speech separation BSS attempts to replicate this feat using computational algorithms It aims to extract individual speech signals from a mixture of sounds without any prior knowledge about the source signals or the mixing process This blind approach makes it particularly challenging but also incredibly versatile allowing for application in scenarios where traditional methods falter Analysis of Current Trends BSS research has undergone a paradigm shift in recent years driven by advancements in machine learning and deep learning

techniques These techniques coupled with the availability of massive datasets have significantly improved the accuracy and robustness of BSS algorithms Lets examine some of the key trends 1 Deep Learning Dominance Deep neural networks DNNs have emerged as the dominant force in BSS Convolutional neural networks CNNs and recurrent neural networks RNNs have shown remarkable success in learning complex nonlinear relationships between mixed and separated signals 2 These models can learn intricate temporal dependencies and spectral patterns present in speech allowing for more accurate separation 2 The Rise of EndtoEnd Systems Traditional BSS algorithms often rely on a pipeline of separate modules for feature extraction source estimation and signal reconstruction In contrast endtoend systems trained with DNNs learn all the necessary steps in a unified framework This approach eliminates the need for manual feature engineering and allows for greater flexibility in adapting to diverse acoustic environments 3 MultiChannel BSS The majority of BSS research has focused on separating sources from a single microphone However with the increasing availability of multimicrophone systems multichannel BSS has gained traction By leveraging spatial information from multiple microphones these methods can significantly improve separation performance especially in noisy environments 4 Unsupervised and SemiSupervised Learning While supervised learning methods require labeled data for training unsupervised and semi supervised approaches have gained momentum in BSS These techniques aim to extract meaningful information from unlabeled data reducing the reliance on costly and time consuming annotation processes Discussion of Ethical Considerations Despite the impressive progress in BSS ethical considerations must be carefully addressed The ability to separate individual voices from a mixture of sounds raises potential concerns regarding privacy bias and misuse 1 Privacy Concerns BSS technologies could be used to extract private conversations from recordings without the consent of individuals involved This raises concerns about the

potential for surveillance and unauthorized eavesdropping 2 Bias in Algorithms BSS algorithms are trained on large datasets which may contain biases inherent in the real world This can result in algorithms that perform poorly for certain demographics or accent groups perpetuating existing social inequalities 3 Potential for Misuse 3 The ability to separate individual voices can be exploited for malicious purposes For instance it could be used to manipulate audio recordings create fake evidence or spread misinformation Addressing Ethical Challenges To mitigate these ethical challenges it is crucial to Promote Transparency Openly discussing the limitations and potential misuse of BSS technologies with the public Develop Robust Privacy Protections Implementing strong data anonymization and access control mechanisms to protect individual privacy Ensure Fairness and Inclusivity Employ diverse datasets for training algorithms reducing bias and improving performance for various demographics Foster Responsible Development Encourage ethical considerations in BSS research and development promoting responsible and ethical use of the technology Conclusion Blind speech separation is a rapidly evolving field with immense potential for revolutionizing the way we interact with sound Advancements in machine learning and deep learning have significantly enhanced the accuracy and robustness of BSS algorithms paving the way for numerous applications in various domains However it is imperative to approach this technology with a strong ethical compass ensuring that it benefits society while safeguarding individual privacy and preventing its misuse By addressing ethical concerns and promoting responsible development we can harness the power of BSS to create a more inclusive and accessible audio world

Speech Separation by Humans and MachinesBlind Speech SeparationAudio Source SeparationAudio Source Separation and Speech EnhancementComputer ApplicationsArtificial Intelligence and Machine LearningAdvances in Information and

Communication TechnologyMobile Multimedia CommunicationsThe 13th Conference on Information Technology and Its ApplicationsProceedings of the International Conference on Paradigms of Communication, Computing and Data SciencesComputational Intelligence in Engineering ScienceTime-domain Deep Neural Networks for Speech SeparationMethods for Co-channel Speech SeparationSingle-channel Speech Separation Based on Instantaneous FrequencyImproving Speech Separation by Acoustic Echo CancellationEnd-to-end Speech Separation with Neural NetworksRobust Automatic Speech Recognition by Integrating Speech SeparationDeep Learning for Speech SeparationSpeech Separation Based on Higher Order Statistics Using Recurrent Neural NetworksImplementation and Evaluation of Gated Recurrent Unit for Speech Separation and Speech Enhancement Pierre Divenyi Shoji Makino Shoji Makino Emmanuel Vincent Haipeng Yu Hai Jin Phung Trung Nghia Junyi Wang Ngoc Thanh Nguyen Mohit Dua Ngoc Thanh Nguyen Tao Sun Alvin A. Garcia Lingyun Gu Christian Siegwart Yi Luo Peidong Wang Alfredo Zermini Yan Li Sagar Shah

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Using Recurrent Neural Networks Implementation and Evaluation of Gated Recurrent Unit for Speech Separation and Speech Enhancement *Pierre Divenyi Shoji Makino Shoji Makino Emmanuel Vincent Haipeng Yu Hai Jin Phung Trung Nghia Junyi Wang Ngoc Thanh Nguyen Mohit Dua Ngoc Thanh Nguyen Tao Sun Alvin A. Garcia Lingyun Gu Christian Siegwart Yi Luo Peidong Wang Alfredo Zermini Yan Li Sagar Shah*

this book is appropriate for those specializing in speech science hearing science neuroscience or computer science and engineers working on applications such as automatic speech recognition cochlear implants hands free telephones sound recording multimedia indexing and retrieval

we are surrounded by sounds such a noisy environment makes it di cult to obtain desired speech and it is di cult to converse comfortably there this makes it important to be able to separate and extract a target speech signal from noisy observations for both man machine and human human communication blindsourceseparation bss isanapproachforestimatingsourcesignals using only information about their mixtures observed in each input channel the estimation is performed without possessing information on each source such as its frequency characteristics and location or on how the sources are mixed the use of bss in the development of comfortable acoustic com nication channels between humans and machines is widely accepted some books have been published on bss independent component ana sis ica and related subjects there ica based bss has been well studied in the statistics and information theory elds for applications to a variety of disciplines including wireless communication and biomedicine however as speech and audio signal mixtures in a real reverberant environment are generally convolutive mixtures they involve a structurally much more ch

LENGING TASK THAN INSTANTANEOUS MIXTURES WHICH ARE PREVALENT IN MANY OTHER APPLICATIONS

THIS BOOK PROVIDES THE FIRST COMPREHENSIVE OVERVIEW OF THE FASCINATING TOPIC OF AUDIO SOURCE SEPARATION BASED ON NON NEGATIVE MATRIX FACTORIZATION DEEP NEURAL NETWORKS AND SPARSE COMPONENT ANALYSIS THE FIRST SECTION OF THE BOOK COVERS SINGLE CHANNEL SOURCE SEPARATION BASED ON NON NEGATIVE MATRIX FACTORIZATION NMF AFTER AN INTRODUCTION TO THE TECHNIQUE TWO FURTHER CHAPTERS DESCRIBE SEPARATION OF KNOWN SOURCES USING NON NEGATIVE SPECTROGRAM FACTORIZATION AND TEMPORAL NMF MODELS IN SECTION TWO NMF METHODS ARE EXTENDED TO MULTI CHANNEL SOURCE SEPARATION SECTION THREE INTRODUCES DEEP NEURAL NETWORK DNN TECHNIQUES WITH CHAPTERS ON MULTICHANNEL AND SINGLE CHANNEL SEPARATION AND A FURTHER CHAPTER ON DNN BASED MASK ESTIMATION FOR MONAURAL SPEECH SEPARATION IN SECTION FOUR SPARSE COMPONENT ANALYSIS SCA IS DISCUSSED WITH CHAPTERS ON SOURCE SEPARATION USING AUDIO DIRECTIONAL STATISTICS MODELLING MULTI MICROPHONE MMSE BASED TECHNIQUES AND DIFFUSION MAP METHODS THE BOOK BRINGS TOGETHER LEADING RESEARCHERS TO PROVIDE TUTORIAL LIKE AND IN DEPTH TREATMENTS ON MAJOR AUDIO SOURCE SEPARATION TOPICS WITH THE OBJECTIVE OF BECOMING THE DEFINITIVE SOURCE FOR A COMPREHENSIVE AUTHORITATIVE AND ACCESSIBLE TREATMENT THIS BOOK IS WRITTEN FOR GRADUATE STUDENTS AND RESEARCHERS WHO ARE INTERESTED IN AUDIO SOURCE SEPARATION TECHNIQUES BASED ON NMF DNN AND SCA

LEARN THE TECHNOLOGY BEHIND HEARING AIDS SIRI AND ECHO AUDIO SOURCE SEPARATION AND SPEECH ENHANCEMENT AIM TO EXTRACT ONE OR MORE SOURCE SIGNALS OF INTEREST FROM AN AUDIO RECORDING INVOLVING SEVERAL SOUND SOURCES THESE TECHNOLOGIES ARE AMONG THE MOST STUDIED IN AUDIO SIGNAL PROCESSING TODAY AND BEAR A CRITICAL ROLE IN THE SUCCESS OF HEARING AIDS HANDS FREE PHONES VOICE COMMAND AND OTHER NOISE ROBUST AUDIO ANALYSIS SYSTEMS AND MUSIC POST PRODUCTION SOFTWARE RESEARCH ON THIS

topic has followed three convergent paths starting with sensor array processing computational auditory scene analysis and machine learning based approaches such as independent component analysis respectively this book is the first one to provide a comprehensive overview by presenting the common foundations and the differences between these techniques in a unified setting key features consolidated perspective on audio source separation and speech enhancement both historical perspective and latest advances in the field e g deep neural networks diverse disciplines array processing machine learning and statistical signal processing covers the most important techniques for both single channel and multichannel processing this book provides both introductory and advanced material suitable for people with basic knowledge of signal processing and machine learning thanks to its comprehensiveness it will help students select a promising research track researchers leverage the acquired cross domain knowledge to design improved techniques and engineers and developers choose the right technology for their target application scenario it will also be useful for practitioners from other fields e g acoustics multimedia phonetics and musicology willing to exploit audio source separation or speech enhancement as pre processing tools for their own needs

this two volume set ccis 2274 and ccis 2275 constitutes the refereed proceedings of the 39th national conference on china computer federation ccf ncca 2024 held in harbin china during july 15 18 2024 the 48 full papers presented here were carefully reviewed and selected from 238 submissions these papers are organized in the following topical sections part i artificial intelligence and applications data science and technology part ii pattern recognition machine learning network communication and security frontier and comprehensive applications data science and technology

This CCIS volume constitutes the refereed proceedings of Second International Artificial Intelligence Conference on Artificial Intelligence and Machine Learning IAIC 2024 held in Jinyun China November 2024 the 38 full papers presented were carefully reviewed and selected from 100 submissions They were organized in following topical sections as follows Part I Artificial Intelligence in Real World Applications Part II Artificial Intelligence in Network and Security Systems

This book provides a comprehensive overview of cutting edge research and innovations in information and communication technology ICT offering new insights into both theoretical foundations and practical applications The book contains two keynote abstracts and 115 best peer reviewed papers selected from the 211 submissions at the 3rd International Conference on Advances in ICT ICTA 2024 which share research results and practical applications in ICT research and education The topics cover all ICT related areas and their contributions to socio economic development focusing on the most advanced technologies such as AI researchers and practitioners in academia and industry can use the book as a valuable reference for their research activities teaching learning and advancing current technologies The conference is hosted by Hung Vuong University HVU with primary organizing support from Thai Nguyen University of Information and Communication Technology ICTU

This proceedings constitutes the referred post conference proceedings of the 16th International Conference on Mobile Multimedia Communications MobiMedia 2023 held in Guilin China during July 22 24 2023 the 35 full papers and 17 short papers presented were carefully selected from 77 submissions The papers were organized as follows cutting edge technologies in wireless communication in information as well as topics of signal processing and new generation wireless

COMMUNICATION

THIS BOOK PRESENTS SELECTED PAPERS FROM THE 13TH INTERNATIONAL CONFERENCE ON INFORMATION TECHNOLOGY AND ITS APPLICATIONS CITA 2024 WHICH TOOK PLACE ON JULY 19 20 2024 THE 13TH CITA WILL BE HOSTED BY THE VIETNAM KOREA UNIVERSITY OF INFORMATION AND COMMUNICATION TECHNOLOGY VKU A MEMBER OF UNIVERSITY OF DANANG WITH THE SUPPORTS OF THE RESEARCHING AND TRAINING INSTITUTIONS BELONGING TO ASEAN CONSORTIUM FOR INNOVATION AND RESEARCH ACIR AS WELL AS VIETNAM ICT ASSOCIATION OF FACULTIES INSTITUTES SCHOOL UNIVERSITIES FISU VIETNAM THE CONFERENCE WILL TAKE PLACE IN DA NANG CITY AND HOI AN CITY WHICH ARE BEAUTIFUL AND LIVABLE CITIES IN VIETNAM ALL PAPERS SUBMITTED TO CITA 2024 ARE REVIEWED SERIOUSLY CLOSELY AND THOROUGHLY BY 02 04 REVIEWERS WITH APPROPRIATE EXPERTISE WITH PROFESSIONAL ADVICE FROM REPUTABLE SCIENTISTS IN THE FIELDS OF INFORMATION AND COMMUNICATION TECHNOLOGY OVER THE PAST 13 YEARS OF ESTABLISHMENT AND DEVELOPMENT CITA HAS BECOME AN INTERNATIONAL SCIENTIFIC CONFERENCE WITH A PRESTIGIOUS BRAND IN THE SCIENTIFIC COMMUNITY NOT ONLY IN VIETNAM BUT ALSO AROUND THE WORLD IN THE FIELD OF ICT AND DIGITAL ECONOMY FOR THIS EDITION OF THE CONFERENCE WE HAVE RECEIVED IN TOTAL 173 PAPERS WHOSE AUTHORS COME FROM OVER 25 COUNTRIES AROUND THE WORLD ONLY 43 PAPERS OF THE HIGHEST QUALITY WERE SELECTED FOR ORAL PRESENTATION AND PUBLICATION IN THIS LNNS VOLUME THE AVERAGE RATE OF PAPERS ACCEPTED BY THIS VOLUME IS ABOUT 25 PAPERS INCLUDED IN THESE PROCEEDINGS COVER THE FOLLOWING TOPICS DATA SCIENCE AND ARTIFICIAL INTELLIGENCE IMAGE AND NATURAL LANGUAGE PROCESSING SOFTWARE ENGINEERING AND INFORMATION SYSTEM NETWORK AND COMMUNICATIONS AND DIGITAL ECONOMY THE ACCEPTED AND PRESENTED PAPERS FOCUS ON NEW TRENDS AND CHALLENGES FACING INFORMATION TECHNOLOGY AND ITS APPLICATIONS THE PRESENTERS SHOW HOW RESEARCH WORKS CAN STIMULATE NOVEL AND INNOVATIVE APPLICATIONS WE HOPE THAT YOU FIND THESE RESULTS USEFUL AND INSPIRING FOR YOUR FUTURE RESEARCH WORK

this book gathers selected high quality research papers presented at the international conference on paradigms of communication computing and data sciences pccds 2021 held at the national institute of technology kurukshetra india during may 07 09 2021 it discusses high quality and cutting edge research in the areas of advanced computing communications and data science techniques the book is a collection of latest research articles in computation algorithm communication and data sciences intertwined with each other for efficiency

this four volume set constitutes the refereed proceedings of the first international conference on on computational intelligence in engineering science iccies 2025 in ho chi minh city vietnam during july 23 25 2025 the 115 full papers presented in these proceedings were carefully reviewed and selected from 210 submissions the papers are organized in the following topical sections part i machine learning wireless networks 6g part ii computer vision natural language processing part iii intelligent systems internet of things part iv machine learning control systems

speech separation separates the speech of interest from background noise speech enhancement or interfering speech speaker separation while the human auditory system has extraordinary speech separation capabilities designing artificial models with similar functions has proven to be very challenging recently waveform deep neural network dnn has become the dominant approach for speech separation with great success improving speech quality and intelligibility is a primary goal for the speech separation tasks integrating human speech elements into waveform dnns has proven to be a simple yet effective strategy to boost objective performance including speech quality and intelligibility of speech separation models in this dissertation three solutions are proposed to integrate human speech elements into waveform speech separation

solutions in an effective manner first we propose a knowledge assisted framework to integrate pretrained self supervised speech representations to boost the performance of speech enhancement networks to enhance the output intelligibility we design auxiliary perceptual loss functions that rely on speech representations pretrained on large datasets to ensure the denoised network outputs sound like clean human speeches our second solution is for speaker separation where we design a speaker conditioned model that adopts a pretrained speaker identification model to generate speaker embeddings with rich speech information our third solution takes a different approach to improve speaker separation solutions to suppress information of non target speakers in auxiliary loss based solutions we introduce a loss function that can maximize the distance between speech representations of separated speeches and speeches of clean non target speakers in this dissertation we also address a practical issue in frame based dnn se solution frame stitching where the input context to be observed in a network is often limited resulting in boundary discontinuities in network outputs we use recurrent neural network rnn to connect depthwise fully convolution networks fcns allowing temporal information to be propagated along the networks on individual frames our fcn rnn model demonstrates excellent smoothing effect on short frames enabling speech enhancement systems with very short delays

bachelorarbeit aus dem jahr 2012 im fachbereich informatik theoretische informatik note 1 0 universit? t des saarlandes sprachsignalverarbeitung sprache deutsch abstract diese bachelorarbeit umfasst die themen acoustic echo cancellation und speech separation zun? chst wird ein acoustic echo cancellation system in matlab im plementiert und anschlie? end werden teile dieses systems f? r die sprachtrennung genutzt die experimente zur sprachtrennung werden mit einem automatischen spracherkennungsystem ausgewertet und mit hilfe des benutzten filters ist eine deutliche verbesserung der sprachtrennung zu

beobachten das system erreicht eine word error rate von 44 20 dies entspricht einer verbesserung von 24 im vergleich zum superdirective beamformer

i start with a single channel pipeline which we refer to as the time domain audio separation network tasnet to validate the advantage of end to end separation comparing with the conventional time frequency domain pipelines i then move to the multi channel scenario and introduce the filter and sum network fasnet for both fixed geometry and ad hoc geometry microphone arrays next i introduce methods for lightweight network architecture design that allows the models to maintain the separation performance while using only as small as 2 5 model size and 17 6 model complexity after that i look into the training objective functions for end to end speech separation and describe two training objectives for separating varying numbers of sources and improving the robustness under reverberant environments respectively finally i take a step back and revisit several problem formulations in end to end separation pipeline and raise more questions in this framework to be further analyzed and investigated in future works

automatic speech recognition asr has been used in many real world applications such as smart speakers and meeting transcription it converts speech waveform to text making it possible for computers to understand and process human speech when deployed to scenarios with severe noise or multiple speakers the performance of asr degrades by large margins robust asr refers to the research field that addresses such performance degradation conventionally the robustness of asr models to background noise is improved by cascading speech enhancement frontends and asr backends this approach introduces distortions to speech signals that can render speech enhancement useless or even harmful for asr as for the

robustness of asr models to speech overlaps traditional frontends cannot use speaker profiles efficiently in this dissertation we investigate the integration of asr backends with speech separation including speech enhancement and speaker separation frontends we start our work by improving the performance of acoustic models in asr we propose an utterance wise recurrent dropout method for a recurrent neural network rnn based acoustic model with utterance wise context better exploited the word error rate wer reduces substantially we also propose an iterative speaker adaptation method that can adapt the acoustic model to different speakers using the asr output from the previous iteration to obtain a better trade off between noise reduction and speech distortion for robust monaural i e single channel asr we train the acoustic model with a large variety of enhanced speech generated by a monaural speech enhancement model this way the influence of speech distortion to asr can be alleviated we then investigate the use of different types of enhanced features for distortion independent acoustic modeling using distortion independent acoustic modeling with magnitude features as input we obtain the state of the art results on the second chime speech separation and recognition chime 2 corpus multi channel speech enhancement typically introduces less distortion than monaural speech enhancement we first substitute the summation operation in beamforming with a learnable complex domain convolutional layer operations in complex domain leverage both magnitude and phase information we then combine this complex domain idea and a two stage beamforming approach the first stage extracts spatial features and the second stage uses both extracted spatial features and the original spectral features as input this way the second stage exploits spatial and spectral features explicitly using the proposed method we achieve the state of the art result on the 4th chime speech separation and recognition challenge chime 4 corpus while the enhancement of noisy speech leverages the differences between speech and noise in time frequency t

f patterns the separation of overlapped speech needs to use speaker related information we investigate speaker separation using an inventory of speaker profiles containing speaker identity information we first select the speaker profiles involved in overlapped speech using an attention based method the selected speaker profiles are then used together with the original overlapped speech as input for speaker separation to alleviate the problem caused by wrong speaker profile selection we propose to use the output of speaker separation as selected speaker profiles for more iterations of speaker separation finally speech contains sensitive personal data that users may not want to send to cloud based servers for processing next generation asr systems should not only be robust to adverse conditions but also lightweight so that they can be deployed on device we investigate model compression methods for asr that do not need model retraining our proposed weight sharing based model compression method achieves 9 fold compression with negligible performance degradation

hearing aids automatic speech recognition asr and many other communication systems work well when there is just one sound source with almost no echo but their performance degrades in situations where more speakers are talking simultaneously or the reverberation is high speech separation and speech enhancement are core problems in the field of audio signal processing humans are remarkably capable of focusing their auditory attention on a single sound source within a noisy environment by de emphasizing all other voices and interferences in surroundings this capability comes naturally to us humans however speech separation remains a significant challenge for computers it is challenging for the following reasons the wide variety of sound type different mixing environment and the unclear procedure to distinguish sources especially for similar sounds also perceiving speech in low signal noise snr conditions is hard for hearing impaired listeners therefore the motivation is to advance the speech separation algorithms to improve the intelligibility of noisy

speech latest technologies aim to empower machines with similar abilities recently the deep neural network methods achieved impressive successes in various problems including speech enhancement which the task to separate the clean speech of the noise mixture due to the advances in deep learning speech separation can be viewed as a classification problem and treated as a supervised learning problem three main components of speech separation or speech enhancement using deep learning methods are acoustic features learning machines and training targets this work aims to implement a single channel speech separation and enhancement algorithm utilizing machine learning deep neural networks dnns an extensive set of speech from different speakers and noise data is collected to train a neural network model that predicts time frequency masks from noisy and mixture speech signals the algorithm is tested using various noises and combinations of different speakers its performance is evaluated in terms of speech quality and intelligibility in this thesis i am proposing a variant of the recurrent neural network which is gru gated recurrent unit for the speech separation and speech enhancement task it is a simpler model than the lstm long short term memory which is used now for the task of speech enhancement and speech separation consisting of a smaller number of parameters and matching the performance of the speech separation and speech enhancement of lstm networks

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