# Franz Pernkopf

*Curriculum Vitae*

## Contact Information


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Speech Communication
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## Education

7/2010 **Habilitation**, *Venia Docendi for Intelligent Systems*, Graz University of Technology, Austria, Thesis: Graphical Models: Discriminative Learning, Inference, and Applications.

10/1999–3/2002 **Ph.D. (Dr. mont.)**, University of Leoben, Institute for Automation, Austria, Thesis: Automatic Visual Inspection of Metallic Surfaces, with distinction.

10/1994–6/1999 **MSc (Dipl.-Ing.)**, *Electrical Engineering/Biomedical Engineering*, Graz University of Technology, Austria and University of Edinburgh, Scotland (UK), Thesis: Control Software for a 64 by 64 pixel Spatial Light Modulator.

9/1989–6/1994 **Technical College**, *Electrical Engineering*, HTBLA Steyr, Austria, with distinction.

## Professional Experience

9/2019 – present Professor for Intelligent Systems at the Institute of Signal Processing and Speech Communication, Graz University of Technology, Austria.

1/2011 – 8/2019 Associate Professor at the Institute of Signal Processing and Speech Communication, Head of the Intelligent Systems Group, Graz University of Technology, Austria.

06/2010 – 12/2010 Senior Research Scientist at the Institute of Signal Processing and Speech Communication, Graz University of Technology, Austria.

09/2005 – 01/2006 Research Associate (Erwin Schrödinger fellow) at the University of Washington, Department of Electrical Engineering, Seattle, USA.

09/2004 – 05/2010 University Assistant (Assistant Professor level) at the Institute of Signal Processing and Speech Communication, Graz University of Technology, Austria.

12/2003 – 8/2004 Research Associate (Erwin Schrödinger fellow) at the University of Washington, Department of Electrical Engineering, Seattle, USA.

09/2003 – 11/2003 Research Associate (Erwin Schrödinger fellow) at the Oakland University, Department of Computer Science and Engineering, Rochester, USA.

11/2002 – 08/2003 University Assistant (Assistant Professor level) at the Institute of Signal Processing and Speech Communication, Graz University of Technology, Austria.

06/2001 – 10/2002 University Assistant at the Institute for Automation, University of Leoben, Austria.

10/1999 – 05/2001 Research Assistant at the Institute for Automation, University of Leoben, Austria.

## Professional Interests

Machine Learning and Statistical Pattern Recognition; Statistical Data Processing and Modeling; Feature Selection, Graphical Models (Bayesian Networks, Discriminative Parameter and Structure Learning, Belief Propagation); Deep Learning, Bayesian Deep Neural Networks, Particle Filters for Tracking; Data Clustering (Unsupervised Learning and Finite Mixture Models); Intelligent Systems; Medical and Speech Processing Applications.

## Teaching

2011 – 2023 Computational Intelligence (lecture course).

2020 Machine Learning 1 (lecture course).

2011 – 2015 Einführung in die Wissensverarbeitung (lecture course).

2003 – 2019 Speech Communication II (lecture course).

2020 –2023 Automatic Speech Recognition (lecture course).

2008 – 2023 Verfassen wissenschaftlicher Arbeiten (seminar).

2005 – 2019 Advanced Signal Processing Seminar. The following topics have been treated over the years:

- Resource-efficient Neural Networks (WS 2017/2018) - (WS 2019/2020)
- Signal Processing for Assisted Living (WS 2016/2017)
- Acoustic Event Detection, Classification, and Keyword spotting (WS 2015/2016)
- Deep Models and Learning (WS 2014/2015)
- Speech Information Processing (WS 2013/2014)
- Fundamental Technologies in Modern Speech Recognition (SS 2013)
- Signal Processing in Geophysical Problems (WS 2012/2013)
- Probabilistic Models of Cognition (SS 2012)
- Convex Optimization for Signal Processing (WS 2011/2012)
- Graphical Models for Signal Processing (SS 2011)
- Iterative Decoding Methods and Applications (WS 2010/2011)
- Kernel Methods (WS 2009/2010)
- Distributed Signal Processing in Sensor Networks and Applications (WS 2008/2009)
- Biometrics (WS 2007/2008)
- Statistical Machine Translation (WS 2006/2007)
- Graphical Models (SS 2005)

2019 – 2023 Signal Processing and Machine Learning 1 Seminar. The following topics have been treated over the years:
- Physics Informed Neural Networks(WS 2022/2023)
- Explainable AI (WS 2021/2021)
- Resource-efficient Neural Networks (WS 2020/2021)

2003 – 2022 Speech Communication Laboratory.

2003 – 2009 Computational Intelligence (problem class).

2005 – 2009 Einführung in die Wissensverarbeitung (problem class).

2004 – 2022 Digital Signal Processing Laboratory.

2001, 2002 Autonomous Robot Seminar.

2001, 2002 Automatic Surface Inspection (lecture course).

## Research Projects

03/2023 – 02/2026 **Physics-informed Neural Networks for Multibody Dynamics Simulation and its Application to Railway Vehicles**, *Funding: Siemens Mobility Austria GmbH: 296000 €*, Involvement: Project leader.

10/2022 – 9/2029 **CD Laboratory for Dependable Intelligent Systems in Harsh Environments**, *Funding: 1400000 €*, Involvement: Project leader (joint project with RHI Magnesita.

01/2022 – 12/2023 **Effective Construction of Hybrid Semi-Parametric Models for Model-Based Condition Monitoring and Accelerated Material Design**, *Funding: 200000 €*, joint project with MCL Leoben.

10/2020 – 09/2022 **General Framework for Inference on Graphical Models**, *Funding: 475000 €*, Involvement: Project leader.

10/2021 – 9/2024 **Robust and ExPlainable AI for Radarsensors**, *Funding institution: FFG, Total: 351.000 €, SPSC: 236.000 €*, Involvement: Project leader (joint project with Infineon Technolgogies Austria AG.

03/2019 – 02/2022 **Dependable Internet of Things in Adverse Environments, Subproject: Dependable Multi-Agent Systems**, *Funding institution: LEAD Project (excellence programm at TU Graz), 150000 €.*

01/2018 – 06/2019 **Artificial Intelligence in Motion Laboratoy (aiMotionLab)**, *Funding institution: Land Steiermark, Total: 390000 €, SPSC: 334000 €*, Involvement: joint project with FH Joanneum (project leader) and University of Leoben.

1/2018 – 12/2020 **Smart Accelerated Hardware for Radar Sensors enabling Autonomous Driving**, *Funding institution: FFG, Total: 518.396 €, SPSC: 259.131 €*, Involvement: Project leader (joint project with Infineon Technolgogies Austria AG, Magna Steyr Engineering AG & CoKG).

10/2018 – 05/2020 **Automatic and Reliable Classification of Highly Inline Measured Wafer Edge Defects using Embedded Screeners (ARCHIMEDES)**, *Funding institution: FFG, Total: 689.256 €, SPSC: 147.000 €*, Involvement: (joint project with Bright Red Systems GmbH (project leader).

10/2016 – 12/2020 **Resource-Efficient Deep Models for Embedded Systems**, *Funding institution: Austrian Science Fund (FWF), Total: 380000 €, SPSC: 215000 €, I2706-N31*, Involvement: Project leader (joint project with University of Heidelberg, H. Fröning).

01/2017 – 06/2019 **PipeSense**, *Funding institution: Industry, Total: 300000 €, SPSC: 125000 €*, Involvement: Project Leader - Institute of Engineering Geodesy and Measurement Systems, Graz University of Technology, Partners: (joint project with Graz University of Technology, Institute of Engineering Geodesy and Measurement Systems, Österreichische Vereinigung für Gas- und Wasserfach, Energienetze Steiermark GmbH, Linz Gas Netz GmbH, Netz Burgenland Erdgas GmbH, Netz Niederösterreich GmbH, Netz Oberösterreich GmbH, Salzburg Netz GmbH.

07/2016 – 09/2016 **Anschubfinanzierung**, *Funding institution: TU Graz, 7000 €*.

01/2015 – 12/2019 **Multichannel Acoustic Event Classification and Recognition for Low-resource Platforms**, *Funding institution: Industry, 150000 €*, Involvement: Project Leader, Partner: Ognios GmbH, Salzburg, Austria.

01/2016 – 06/2019 **Dependable Internet of Things in Adverse Environments, Subproject: Dependable Composition**, *Funding institution: LEAD Project (excellence programm at TU Graz), 150000 €*.

07/2015 – 06/2018 **Learning of Bayesian Network Classifiers and Sum-Product Networks**, *Funding institution: Austrian Science Fund (FWF), 260000 €, P27803-N15*, Involvement: Project leader.

03/2015 – 07/2015 **Anschubfinanzierung**, *Funding institution: TU Graz, 7300 €*.

03/2015 – 02/2017 **Brain, Ears & Eyes - Pattern Recognition Intiative**, *Funding institution: BioTechMed Graz, 120000 €*, Involvement: Project leader at TU Graz (joint project with Medical University Graz, P. Marschik).

05/2014 – 07/2016 **Computerunterstützte akustische Diagnostik thorakaler Erkrankungen**, *Funding institution: Land Steiermark, Total: 159000 €, SPSC: 100000 €*, Involvement: Project leader (joint project with Medical University Graz, F.-M. Smolle-Juettner).

02/2013 – 08/2016 **Probabilistic Graphical Models For Time-Series Signal Mixtures**, *Funding institution: Austrian Science Fund (FWF), 443000 €, P25244-N15*, Involvement: Project leader.

06/2011 – 12/2014 **National Research Network: Signal and Information Processing in Science and Engineering - Part II, Subproject: Nonlinear Dynamics and Machine Learning**, *Funding institution: Austrian Science Fund (FWF), 328000 €, S10610-N13*, Involvement: Project leader.

06/2011 – 01/2014 **Discriminative Learning of Graphical Models with Application to Speech and Image Processing**, *Funding institution: Austrian Science Fund (FWF), 302000 €, P22488-N23*, Involvement: Project leader.

06/2008 – 05/2011 **National Research Network: Signal and Information Processing in Science and Engineering - Part I, Subproject: Nonlinear Dynamics and Machine Learning**, *Funding institution: Austrian Science Fund (FWF), 270000 €, S10604-N13*, Involvement: Deputy project leader, scientific consultant.

10/2007 – 09/2010 **Discriminative Learning of Bayesian Network Classifiers**, *Funding institution: Austrian Science Fund (FWF), 104000 €, P19737-N15*, Involvement: Project leader.

09/2005 – 01/2006, 12/2003 – 08/2004, 09/2003 – 11/2003 **Shape Description and Classification using Probabilistic Graphical Models**, *Funding institution: Austrian Science Fund (FWF), 50000USD, J2243-N04, Schrödinger Fellowship*, Involvement: Project leader, Partners: University of Washington, Department of Electrical Engineering, Seattle, USA; Oakland University, Department of Computer Science and Engineering, Rochester, USA.

03/2001 – 10/2002 **Detection of Surface Defects on Raw Milled Steel Blocks using Range Imaging**, *Funding institution: Industry*, Involvement: Responsible project collaborator, Partner: Voest Donawitz Stahl, Leoben, Austria.

11/1999 – 12/2000 **Automatic Inspection System for Detection and Classification of Flaws on Turned Parts**, *Funding institution: Industry*, Involvement: Responsible project collaborator, Partner: Mec.Com, Austria.

## Reviewing Activities

Journals IEEE Transactions on Pattern Analysis and Machine Intelligence, JMLR, IEEE Transactions on Audio, Speech, and Language Processing, JASA, IEEE Transactions on Signal Processing, Machine Learning, Pattern Recognition Letters, IEEE Transactions on Data Mining and Knowledge Engineering, Data Mining and Knowledge Discovery, Artificial Intelligence in Medicine, Machine Vision and Applications, International Journal of Approximate Reasoning, IEEE Signal Processing Letters, IEEE Transactions on Medical Imaging, Artificial Intelligence Review, International Journal of Pattern Recognition and Artificial Intelligence.

Conferences ICML 2021, UAI 2021, ICASSP 2021, Interspeech 2021, NeurIPS 2020, ICML 2020, IJCAI-2020, NIPS-2019, IJCAI-2019, ICASSP-2018, ICASSP-2017, Interspeech-2017, NIPS-2016, MLSP-2016, Interspeech-2016, ICASSP-2016, Interspeech-2015, ICASSP-2015, ICML-2014, ICASSP-2014, ICASSP-2013, ICML-2013, Interspeech-2013, EUSIPCO-2014, EUSIPCO-2010; EUSIPCO-2012; EUSIPCO-2013; ITG-Fachtagung-2012, International Symposium on Chinese Spoken Language Processing (ISCSLP 2012)

Funding Institutions DigitalFutures - KTH Sweden, ERC, Czech Science Foundation, Serbia Innovation Project (2011 - 2022)

## Professional Activities and Memberships

2021 Session Chair at the Interspeech 2021

2020, 2021, 2022 Organization of ECML Workshop: IoT, Edge, and Mobile for Embedded Machine Learning (ITEM 2020)

2020 Review Editor in Frontiers in Digital Health - Health Informatics

2020 Senior Program Committee Member of IJCAI 2020

2020 CHiME 2020 workshop Scientific Committee

8/2019 Infineon SummerSchool, Villach, Talk *"Speech Enhancement for ASR using Resource-Efficient Deep Neural Networks"*.

2019 Session Chair at the Interspeech 2019, Graz, Austria

2019 Research Data Management Policy Working Group TU Graz

2019 Senior Program Committee Member of IJCAI 2019

9/2019 Special Sessions & Challenges Chair, Interspeech 2019.

9/2018 Invited Talk, Xilinx, Dublin, Ireland.

5/2018 Invited Talk, University of Passau, Germany.

2017 – Advisory Board of Swiss Innovation Valley AG.

10/2017 Invited Talk, Graz University of Technology, Austria.

10/2017 Invited Talk, University of Heidelberg, Germany.

2017 Session Chair at the Interspeech 2017, Stockholm, Sweden.

6/2017 Invited Talk, University of Innsbruck, Austria.

2017 Habilitation Committee of Pejman Mowlaee Beikzadehmahaleh, Graz University of Technology.

6/2016 Talk, "Efficient Probabilistic Models for Cochlea Implants", Med-El, Innsbruck.

2016 Substitute member of the works council for academic personnel, Graz University of Technology.

2016 Program Committee for the IEEE Workshop on Machine Learning for Signal Processing (MLSP).

2016 Scientific Committee of 4$^{th}$ CHiME Workshop.

1/2015 Invited Talk, "Efficient Probabilistic Models: Learning and Reduced-Precision Analysis", Technical University Munich, Germany.

2015 Scientific Committee of Interspeech.

2014 Signal Processing Theory and Methods (SPTM) Technical Committee of the IEEE Signal Processing Society.

2014 Senior Member of the IEEE.

2013 Coordination Team of the Doctoral School *Information and Communications Engineering* at Graz University of Technology.

2013 Session Chair at the European Conference on Machine Learning (ECML 2013), Prague, Czech Republic.

Invited Tutorial, "Probabilistic Graphical Models", Academic Press Library in Signal Processing, Vol. 1, Ch. 18, pp. 989-1064, 2014.

2008, 2012 Program Committee for the International Conference on Signal and Image Processing (SIP).

06/2011 Invited Talk, "Discriminative Learning of Bayesian Networks and Applications", Machine Learning Technical Meeting, Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), Vienna.

Editorial Board of ISRN Artificial Intelligence.

04/2011 Invited Talk, "Discriminative Learning of Bayesian Network Classifiers", University of Bonn, Bonn.

10/2010 Invited Talk, "Discriminative Learning of Bayesian Network Classifiers", Austrian Research Institute for Artificial Intelligence, Vienna.

10/2009 Invited Talk, "Machine Learning for Speech Processing", ITG Fachgruppe, Graz.

2008 Session Chair at the International Conference on Computer Vision and Computer Graphics Theory and Applications (VISIGRAPP 2008), Madeira, Portugal.

2/2007 Invited Tutorial, "Discriminative learning of Bayesian networks for classification", Tutorial on Pattern Recognition, FTW Forschungszentrum Telekommunikation Wien GmbH, Vienna.

## Awards and Scholarships

2022 WKO Forschungsstipendium, Hannes Bradl

2019 Best Paper Award at ICTSS 2019: B.K.Aichernig, R. Bloem, M. Ebrahimi, M. Horn, F. Pernkopf, W. Roth, A. Rupp, M. Tappler, M. Tranninger, *"Learning a Behavior Model of Hybrid Systems through Combining Model-Based Testing and Machine Learning"*

2016 Finalist of best student paper, *DNN-based Speech Mask Estimation for Eigenvector Beamforming*, ICASSP, 2016.

2016 Finalist of best student paper, *A Robust Multichannel Lung Sound Recording Device*, BIODEVICES, 2016.

2012 Kardinal-Innitzer-Förderungspreis (Kardinal-Innitzer Young Investigator Award), Vienna, Austria.

2010 Young Investigator Award of the Province Styria (Förderungspreis des Landes Steiermark), Graz, Austria.

2010 Finalist of best student paper, *A Factorial Sparse Coder Model for Single Channel Source Separation*, Interspeech, 2010.

2003 Fahrzeugverband-Jubiläumsstiftung Forschungspreis (Fachverband der Fahrzeugindustrie), Wien, Österreich.

2002 Erwin Schrödinger Fellowship, Vienna, Austria.

2002 Erwin-Wenzel-Preis, Linz, Austria.

2002 Fred-Margulies Preis, Vienna, Austria.

## Academic Cooperation Partners (Selected)

- Sebastian Tschiatschek, University of Vienna, Austria.
- Robert Peharz, Graz University of Technology.
- Philipp Aichinger, Medical University Vienna, Austria
- Holger Fröning, University of Heidelberg, Germany.
- Pedro Domingos,Jeff Bilmes, University of Washington, USA.
- Peter Marschik, Freyja-Maria Smolle-Jüttner, Horst Olschewski, Medical University Graz, Austria.

## Soft Skills

2017 Nichts Neues ohne Innovation, Graz University of Technology, Austria.

2017 Psychologische Ansätze zur Personalführung, Graz University of Technology, Austria.

2015 - 2016 Advanced Leadership Program, Graz University of Technology, Austria.
- Hochschuldidaktik für Führungskräfte
- Erfolgreich führen und kommunizieren mit Konzepten der Transaktionsanalyse
- Führungskompetenz kompakt
- Sich und andere verändern
- Strategieentwickung für Führungskräfte
- Arbeitsrecht für Führungskräfte
- Wie wir uns unsere Probleme selber machen

2015 Management von Forschungsprojekten, Graz University of Technology, Austria.

2014 Forschungsprojekt- und Programmmanagement für Projektauftraggeber/innen, Graz University of Technology, Austria.

2010 – 2011 Management Development Program at Graz University of Technology, Austria.

2011 Leading Technical Teams, Graz University of Technology, Austria.

2010, 2011 Didaktik 1,2,3: Durchführen von Lehrveranstaltungen im akademischen Bildungsbereich, Graz University of Technology, Austria.

2010 Erfolgreich in die Öffentlichkeit: Dos and Don'ts für den Umgang mit Medien, Graz University of Technology, Austria.

2009 Führen, Delegieren, Motivieren, Graz University of Technology, Austria.

## Supervised PhD Students

2010 Stefan Petrik, Phonetic Similarity Matching of Non-Literal Transcripts in Automatic Speech Recognition.

2010 Michael Stark, Source-Filter Model Based Single Channel Speech Separation.

2012 Michael Wohlmayr, Probabilistic Model-Based Multiple Pitch Tracking of Speech.

2013 Christina Leitner, Speech Enhancement using Kernel PCA.

2014 Sebastian Tschiatschek, Maximum Margin Bayesian Networks: Asymptotic Consistency, Hybrid Learning, and Reduced-Precision Analysis.

2014 Dietmar Schabus, Audio-visual Speech Synthesis Based on Hidden Markov Models, external PhD Candidate at FTW Forschungszentrum Telekommunikation Wien GmbH, Vienna.

2015 Robert Peharz, Foundations of Sum-Product Networks for Probabilistic Modeling.

2019 Matthias Zöhrer, Speech Enhancement Using Deep Neural Beamformers.

2019 Christian Knoll, Understanding the Behavior of Belief Propagation.

2019 Elmar Messner, A Holistic Approach to Multi-Channel Lung Sound Classification.

2020 Martin Trapp, Sum-Product Networks for Complex Modelling Scenarios, external PhD Candidate at Austrian Research Institute for Artificial Intelligence (OFAI), Vienna.

2021 Lukas Pfeifenberger, Towards the Evolution of Neural Acoustic Beamformers, external PhD Candidate funded from Ognios (industry partner), Salzburg.

2021 Günther Schindler, Compressing and Mapping Deep neural Networks on Edge Computing Systems, external PhD examinor, Ruprecht-Karls University Heidelberg, Germany.

2021 Wolfgang Roth, Probabilistic Methods for Resource Efficiency in Machine Learning.

2022 Truc Nguyen, Robust Lunk Sound and Acoustic Scene Classification.

2022 Johanna Rock, Resource-efficient Neural Networks for Automotive Radar Interference Mitigation.

2022 Alexander Fuchs, Improving Efficiency and Generalization in Deep Learning Models for Industrial Applications

running Harald Leisenberger, Analysis of Belief Propagation

running Christoph Obermair, Data Analysis of LHC

running Christian Toth, Causality

running Nikolaus Mutsam, Predictive Maintenance

running Christian Oswald, ML for Interference Mitigation

running Sophie Steger, Physics-informed Bayesian Neural Networks

running Jixiang Lei, Fault Detection in Offshore Platform, co-supervisor

## Supervised Master Students

2007 Christoph Böhm, Unsupervised Speaker Segmentation in One-Channel Speech Data.

2007 Christian Wallinger, A Flexible Sender-Based Packet Loss Recovery Method.

2008 Christoph Schmauder, Schwingungsanalyse für Störstoffdetektion und Schnittspalteinstellung einer Müllzerkleinerungsmaschine, joint project with Komptech.

2008 Michael Wiesenegger, Wavelet-Based Speaker Change Detection in Single Channel Speech Data.

2010 Robert Peharz, Single Channel Source Separation using Dictionary Design Methods for Sparse Coder.

2012 Gregor Pirker, A Speech Database for Pitch Determination.

2012 Christoph Klug, RTBlocks: A Cross-Platform Algorithm Design Framework for Real-Time Audio Processing on Android.

2013 Nikolaus Mutsam, Maximum Margin Hidden Markov Models.

2013 Klaus Dobbler, Vibroakustisches Monitoring in Smart Homes.

2013 Florian Pokorny, Detection of Negative Emotions in Speech Signals Using Bags-of-Audio-Words.

2013 Lukas Pfeifenberger, Evaluation, Simulation and Implementation of a Multi-Channel Speech Enhancement System.

2013 Andreas Zehetner, Keyword Spotting for Emergency.

2014 C.E. Cancione Chacón, On Belief Propagation and Higher Order Power Methods.

2014 Erwin Nindl, Traffic Flow Reconstruction on Motorways by Data Fusion.

2014 Georg Kapeller, Speech Enhancement with Sum-Product Networks.

2015 Michael Rath, Message Scheduling in Loopy Belief Propagation.

2015 Wolfgang Roth, Hybrid Generative-Discriminative Training of GMMs.

2015 Christopher Walles, Segmental Conditional Random Fields for Phone Recognition.

2016 Johannes S. Innerbichler, Cloud Storage Performance Analysis.

2016 Markus Feuerstein, Refractory Wear Modelling Using Statistical Methods.

2016 Michael Peitler, Acoustic Event Detection of General Sounds.

2017 Fridtjof Sterna, Real-time Automatic Recognition of Spoken Digits on an Embedded System using Deep Recurrent Neural Networks.

2018 Christoph Aigner, Requirements Specification of a Systems-Engineering Tool: Example on Effort Estimation using Neural Networks.

2018 Florian Kulmer, Self-Confident Belief Propagation.

2018 Johanna Rock, Changepoint Detection in Smartphone Usage.

2018 Andreas Wöhrer, 16 Channel USB 2.0 Sound Card for Digital MEMS Microphones.

2018 Andreas Wurm, Predicting the Latency of MQTT Brokers Using Deep Learning.

2019 Hannes Unterholzner, Channel Selection for Distant Automatic Speech Recognition.

2020 Christoph Obermair, Extension of Signal Monitoring Applications with Machine Learning.

2020 Johannes Wolfgruber, Multi-Channel Lung Sound Recording Software.

2020 Christian Toth, Synthesizing Infomap: A Kullback-Leibler Divergence-Based Approach To Community Detection.

2020 Markus Huber, Efficient Single-Channel Music Source Separation with Deep Neural Networks.

2020 Maria Sendlhofer-Schag, Batter Modeling By Means Of Statistical Models.

2020 Raphael Schlüsselbauer, Speech Recognition - A Transfer Learning Approach.

2021 Philipp Gabler, Automatic Graph Tracking in Dynamic Probabilistic Programs via Source Transformations.

2021 Christoph Maurer, Integration and Deployment of Machine Learning Models.

2021 Sebastian Grill, Machine Learning Assisted Heat Detection in Dairy Cows.

2021 David Peter, Resource Efficient Neural Networks for Keyword Spotting.

2021 Michael Hirschmugl, FPGA Implementation of a Compolutional Neural Network for Radar Interference Mitigation.

2022 Christian Oswald, On Optimal Feature Orderings in Bayesian Network Classifiers.

2022 Lukas Längle, Oxygen Saturation Measurements for Anea Divers.

2022 Hannes Bradl, Multi-Instrument Recognition, Mix-Parameter Estimation and Timbre Characterization Using Deep Neural Networks

2022 Leonhard Leopold, Wear Prediction of Refractory Lining using Neural Networks

2022 Lukas Maier, Low-Complexity Convolutional Neural Networks for Acoustic Scene Classification

running Felix Rost, Data Augmentation for Robust Detection/Alignment of Objects

running Christoph, Schögler: DNNs for Future Tradeing of Crypto Coins

running Fabio Ziegler, Refractory Wear Models using Multiple Instance Learning

running Michael Reiter, Covid Classification based on Cough

running Thomas Ntoumanoglou, Graph Structure Optimization for Improving Approximate Inference

running Daniel Zirat, Resource Efficient Single Channel Source Separation

running Martin Hofmann-Wellenhof, Physics Informed Neural Networks for Periodic Signals

## Research Statement

In data science and machine learning, where the amount of available data has increased dramatically over the recent past, intelligent systems modeling complex dependencies are in desperate need for commercial applications. We are at the beginning of a decades-long trend toward data-intensive, evidence-based decision making across many aspects of science and commerce. Steadily increasing data impose new demands such as computationally tractable algorithms, personal data raise the need for algorithms protecting privacy issues, and huge amounts of unlabeled data require learning methods to take advantage of it.

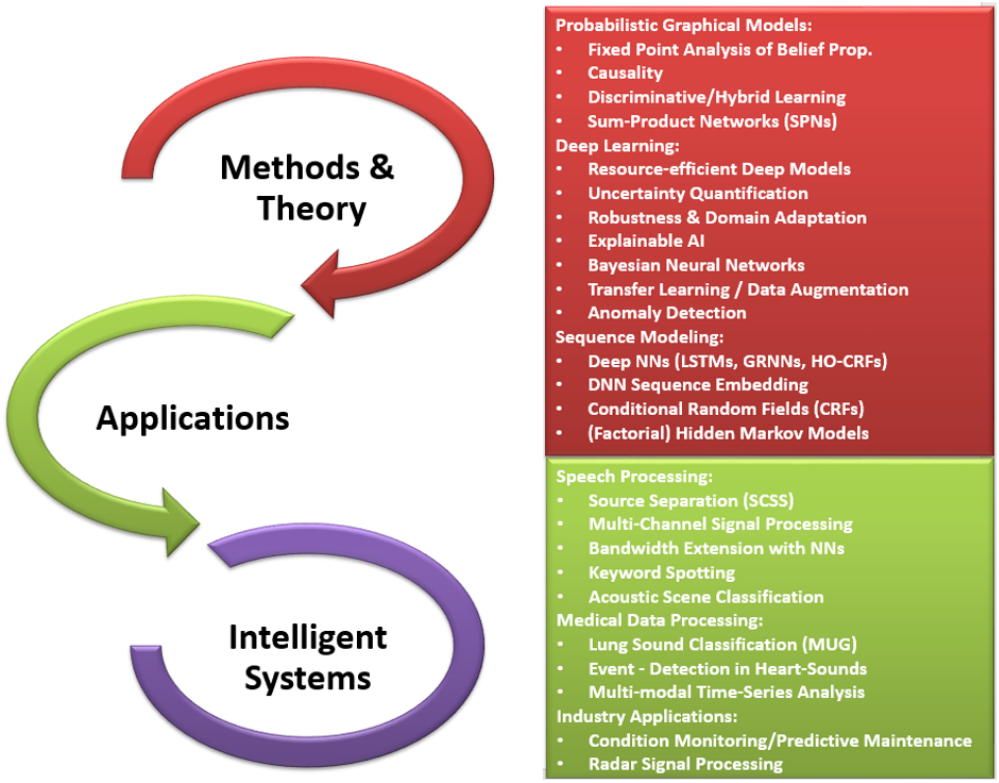


Figure 1: Scope of Research.

My research is focused on pattern recognition, machine learning, and computational data analytics with application in various fields ranging from signal and speech processing to medical data analysis and other data modeling problems from industrial applications. My aim is to bridge the gap between basic research, applications and intelligent systems as shown in Figure 1. There is a mutual benefit, i.e. real-world problems are inspiring the development of basic methods and vice versa. The methods of my current research directions are listed in this figure. At the methods and theory side I am particularly interested in probabilistic graphical models for reasoning under uncertainty, discriminative and hybrid learning paradigms, deep learning, and sequence modeling. Graphical models unite probability and graph theory and allow to efficiently formalize both static and dynamic, as well as linear and nonlinear systems and processes. They provide an approach to deal with two inherent problems throughout applied mathematics and engineering, namely, uncertainty and complexity. In particular, I am interested in how we can specify and learn probabilistic models that can capture higher-order relations among multiple random variables, how we can efficiently reason in such models without an exponential increase in complexity, and how to deal with the computational challenges of inference. My recent interest in deep learning is nourished by the remarkable performance boost in many image, signal and speech processing problems. This is particularly true when having big amounts of data and almost unlimited computing resources available. Here, I am particularly interested in (i) scale-able semi-supervised learning to exploit huge amounts of unlabeled data during learning and in (ii) resource-efficient deep learning for constraint computing infrastructure of real-world applications.

We have successfully published research papers in major machine learning conferences and journals (TPAMI, UAI, ICML, AISTATS, NIPS, JMLR, ECML, AAAI, Pattern Recognition), as well as application oriented journals and conferences for speech and acoustic data processing (TASLP, Speech Communication, ICASSP, Interspeech, ASRU). More details about my research highlights are summarized in the Section *Key Publications* below.

## Industrial Research Collaborations

In addition to purely academic research I successfully established industrial collaborations to unleash the potential of data science and pattern recognition in *real-world cyber-physical* systems. The company Ognios is currently funding a PhD student in the area of resource-efficient deep learning with application to multi-channel speech enhancement. The collaboration with Siemens AG is about data analysis and pattern recognition of rail vehicle data. This also includes to optimize the measurement setup and data hosting in the cloud. The aim is to predict the remaining useful life of the components of a rail-bound traveling mechanism. In a recent project with Infineon Technologies, we are developing a resource-efficient data processing approach for radar sensors to detect obstacles. This sensor is used in the automotive industry.

## Prospective Research

Despite its practical and commercial success, there are many under-explored research opportunities. Ultimately, the question is how to construct systems that automatically improve through experience. My long-term goal is to continue to contribute to the knowledge of modeling, learning and reasoning of complex highly-dependable large-scale data. The insights enable new and improved services for science and society including health care, manufacturing, education amongst many other fields. In my future research I aim to address the questions: How can we build sufficiently structured models and systems allowing for tractable reasoning, trading-off running time, computational requirements and prediction accuracy? How can we build self-adaptive tractable systems by making use of complex heterogeneous large-scale data? How can we make systems amenable for end-to-end learning. In order to make progress on these long-term goals and to tackle these challenges, we need to identify intermediate steps and directions along the way, some of which I outline in the following:

1. Hardware-aware machine learning: While machine learning is traditionally a resource intensive task, embedded systems and the vision of the Internet-of-Things fuel the interest in resource efficient approaches. These approaches require a carefully chosen trade-off between performance and resource consumption in terms of computation and energy. On top of this, it is crucial to treat uncertainty in a consistent manner in all but the simplest applications of machine learning systems. In particular, a desideratum for any real-world system is to be robust in the presence of outliers and corrupted data, as well as being "aware" of its limits, i.e. the system should maintain and provide an uncertainty estimate over its own predictions. These complex demands are among the major challenges in current machine learning research and key to ensure a smooth transition of machine learning technology into every day's applications. The growing interest in deploying neural networks (NNs) on embedded devices has led to plenty of research investigating NNs with low precision weights. While most methods involve a quantization step, we are interested in a Bayesian approach where we first infer a distribution over a discrete weight space from which we subsequently derive hardware-friendly low precision NNs.
2. Computational medicine: Computational methods for the analysis of lung sounds offer advantages for medical diagnosis such as digital storage, monitoring in critical care settings, computer-supported analysis, and comparison among different sound recordings. Despite these advantages, computational lung sound analysis is still suffering for being a major tool in diagnosis. One reason is the lack of efficiency and performance due to the variability in the recorded data. We exploit *deep learning* for computational lung sound analysis to support medical diagnosis. In particular, the focus is two-fold: (i) In a clinical trial we record a high-quality multi-channel lung sound corpus for diseases/conditions such as pneumothorax, congestive heart failure, idiopathic pulmonary fibrosis, pneumonia, bronchitis and pleuritis using our recently developed multi-channel recording device. (ii) Development of computational methods for automatic lung sound analysis. In particular, we work on *deep learning* methods to automatically detect acoustic events (adventitious lung sounds, varying body sounds and noise) in the multi-channel recordings and classify healthy and several categories of pathological lung sounds.

Furthermore, with Philipp Aichinger at the Medical University in Vienna we are jointly working on the analysis of pathological voices by means of signal processing methods.

3. Probabilistic graphical models for reasoning under uncertainty: Many well-known statistical models, e.g., (dynamic) Bayesian networks, mixture models, factor analysis, hidden Markov models, Kalman Filters, Boltzmann machines, the Ising model, et cetera, can be represented by graphical models. The framework of graphical models provides techniques for inference (sum/max-product algorithm also known as belief propagation) and learning. Discriminative learning of Bayesian networks for classification tasks is often beneficial compared to generative learning. This is particularly true in case of model mismatch, i.e. the classifier model can not represent the true data distribution. We developed maximum margin parameter learning for probabilistic graphical models. Furthermore, we used the margin objective for structure learning. The research perspective for the next years is as follows:
   - We aim to exploit homotopy methods to gain insights in the fixed points of loopy belief propagation.
   - We aim at extending our discriminative learning framework to semi-supervised, missing features, and latent variable scenarios. This requires efficient inference during iterative parameter optimization.

## Key Publications

Most of my research relates to the area of machine learning, statistical modeling, and artificial intelligence. In particular, the focus is on developing innovative methods and techniques for extraction of information and modeling of data including the empirical verification of the methods. In the sequel, some key publications (ordered by year) including a short summary are listed.

1. E. Messner, M. Zöhrer, F. Pernkopf, *"Heart Sound Segmentation - An Event Detection Approach using Deep Recurrent Neural Networks"*, IEEE Transaction on Biomedical Engineering (TBME), Vol. 65, No. 9, pp. 1964–1974, 2018.

   We accurately detect the state-sequence first heart sound (S1) - systole - second heart sound (S2) - diastole, i.e. the positions of S1 and S2, in heart sound recordings. We propose an event detection approach, without explicitly incorporating a priori information of the state duration. This renders it also applicable to recordings with cardiac arrhythmia and extendable to the detection of extra heart sounds (third and fourth heart sound), heart murmurs, as well as other acoustic events. Methods: We use data from the 2016 PhysioNet/CinC Challenge, containing heart sound recordings and annotations of the heart sound states. From the recordings, we extract spectral and envelope features and investigate the performance of different deep recurrent neural network (DRNN) architectures to detect the state-sequence. We use virtual-adversarial training (VAT), dropout and data augmentation for regularization. Results: We compare our results with the state-of-the-art method and achieve an average score for the four events of the state-sequence of F 1 96% on an independent test set.

2. C.Knoll, D. Mehta, T.Chen, F. Pernkopf, *"Fixed Points of Belief Propagation - An Analysis via Polynomial Homotopy Continuation"*, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 40, No. 9, pp. 2124–2136, 2018.

   Belief propagation (BP) is an iterative method to perform approximate inference on arbitrary graphical models. Whether BP converges and if the solution is a unique fixed point depends on both the structure and the parametrization of the model. To understand this dependence it is interesting to find all fixed points. In this work, we formulate a set of polynomial equations, the solutions of which correspond to BP fixed points. To solve such a nonlinear system we present the numerical polynomial-homotopy-continuation (NPHC) method. Experiments on binary Ising models and on error-correcting codes show how our method is capable of obtaining all BP fixed points. On Ising models with fixed parameters we show how the structure influences both the number of fixed points and

the convergence properties. We further asses the accuracy of the marginals and weighted combinations thereof. Weighting marginals with their respective partition function increases the accuracy in all experiments. Contrary to the conjecture that uniqueness of BP fixed points implies convergence, we find graphs for which BP fails to converge, even though a unique fixed point exists. Moreover, we show that this fixed point gives a good approximation, and the NPHC method is able to obtain this fixed point.

3. R. Peharz, R. Gens, F. Pernkopf, P. Domingos, *"On the Latent Variable Interpretation in Sum-Product Networks"*, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 39, No. 10, pp. 2030–2044, 2017.

   One of the central themes in Sum-Product networks (SPNs) is the interpretation of sum nodes as marginalized latent variables (LVs). This interpretation allows the application of the EM algorithm and to efficiently perform MPE inference. In literature, the LV interpretation was justified by explicitly introducing the indicator variables corresponding to the LVs' states. However, as pointed out in this paper, this approach is in conflict with the completeness condition in SPNs and does not fully specify the probabilistic model. We propose a remedy for this problem by modifying the original approach for introducing the LVs, which we call SPN augmentation. We discuss conditional independencies in augmented SPNs, formally establish the probabilistic interpretation of the sum-weights and give an interpretation of augmented SPNs as Bayesian networks. Based on these results, we find a sound derivation of the EM algorithm for SPNs, which was presented mistaken in literature. Furthermore, the Viterbi-style algorithm for MPE proposed in literature was never proven to be correct. We show that this is indeed a correct algorithm, when applied to selective SPNs, and in particular when applied to augmented SPNs.

4. S. Tschiatschek and F. Pernkopf, *"On Bayesian Network Classifiers with Reduced Precision Parameters"*, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 37, No. 4, pp. 774–785, 2015.

   For Bayesian network classifiers (BNCs) we performed reduced-precision analysis and published several papers. In this paper, we present novel theoretical results and extended empirical results for BNCs with finite precision fixed-point parameters. All our results are based on the assumption that parameters are learned in full-precision and rounded to the desired precision for classification. We derive three types of bounds on the classification performance after parameter precision reduction and compare these in experiments. Additionally, we empirically compare the classification performance and robustness of BNCs with respect to precision reduction for different learning paradigms.

5. M. Zöhrer, R. Peharz, and F. Pernkopf, *"Representation Learning for Single-Channel Source Separation and Bandwidth Extension"*, IEEE Transactions on Audio, Speech, and Language Processing, Vol. 23, No. 12 pp. 2398–2409, 2015.

   In this paper, we use deep representation learning for model-based single-channel source separation (SCSS) and artificial bandwidth extension (ABE). Both tasks are ill-posed and source-specific prior knowledge is required. In addition to well-known generative models such as restricted Boltzmann machines and higher order contractive autoencoders two recently introduced deep models, namely generative stochastic networks (GSNs) and sum-product networks (SPNs), are used for learning spectrogram representations. For SCSS we evaluate the deep architectures on data of the $2^{\text{nd}}$ CHiME speech separation challenge and provide results for a speaker dependent, a speaker independent, a matched noise condition and an unmatched noise condition task. GSNs obtain the best PESQ and overall perceptual score on average in all four tasks. Similarly, frame-wise GSNs are able to reconstruct the missing frequency bands in ABE best, measured in frequency-domain segmental SNR.

6. M. Zöhrer, F. Pernkopf, *"General Stochastic Networks for Classification"*, Neural Information Processing Systems (NIPS), 2014.

   In this work, we introduce a new training procedure for supervised learning of representations. In particular we define a hybrid training objective for general stochastic networks, dividing the cost function into a generative and discriminative part, controlled by a trade-off parameter. We are able to obtain state-of- the-art performance on the MNIST dataset, without using permutation invariant digits and significantly outperform baseline models on sub-variants of the MNIST and rectangle database.

7. M. Wohlmayr and F. Pernkopf, *"Model-Based Multiple Pitch Tracking Using Factorial HMMs: Model Adaptation and Inference"*, IEEE Transactions on Audio, Speech, and Language Processing, Vol. 21, No. 8, pp. 1742–1754, 2013.

   Robustness against noise and interfering audio signals is one of the challenges in speech recognition and audio analysis technology. One avenue to approach this challenge is single-channel multiple-source modeling. Factorial hidden Markov models (FHMMs) are capable of modeling acoustic scenes with multiple sources interacting over time. While these models reach good performance on specific tasks, there are still serious limitations restricting the applicability in many domains. In this paper, we generalize these models and enhance their applicability. In particular, we develop an EM-like iterative adaptation framework which is capable to adapt the model parameters to the specific situation (e.g. actual speakers, gain, acoustic channel, etc.) using only speech mixture data. Currently, source-specific data is required to learn the model. Inference in FHMMs is an essential ingredient for adaptation. We develop efficient approaches based on observation likelihood pruning. Both adaptation and efficient inference are empirically evaluated for the task of multipitch tracking using the GRID corpus.

8. R. Peharz, S. Tschiatschek, F. Pernkopf, *"The Most Generative Maximum Margin Bayesian Networks"*, International Conference on Machine Learning (ICML), 2013.

   This paper introduces hybrid parameter learning of Bayesian networks (BNs). BNs represent distributions and are therefore well-suited for generative learning. Even when the conditional distribution obtained by discriminative training of BNs is unique, the representation as a BN might be not unique. A natural approach is to use this degree of freedom to improve the generative aspect of the model, i.e. to select the representation with highest likelihood. This describes a domain of likelihood-aware discriminative models, justifying a generative usage, such as sampling new examples, versatile inference scenarios, and consistent treatment of missing features during test time. We use a large margin formulation for discriminative training, introducing a likelihood-weighted $\ell^1$-norm. This simultaneously optimizes the data likelihood and therefore partly maintains the generative character of the model. For many network structures, our method can be formulated as a convex problem, guaranteeing a globally optimal solution.

9. F. Pernkopf, M. Wohlmayr, S. Tschiatschek, *"Maximum Margin Bayesian Network Classifiers"*, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 34, No. 3, pp. 521–532, 2012.

   We present a maximum margin parameter learning algorithm for Bayesian network classifiers using a conjugate gradient (CG) method for optimization. In contrast to previous approaches, we maintain the normalization constraints on the parameters of the Bayesian network during optimization, i.e., the probabilistic interpretation of the model is not lost. This enables us to handle missing features in discriminatively optimized Bayesian networks. In experiments, we compare the classification per-

formance of maximum margin parameter learning to conditional likelihood and maximum likelihood learning approaches. Discriminative parameter learning significantly outperforms generative maximum likelihood estimation for naive Bayes and tree augmented naive Bayes structures on all considered data sets. Furthermore, maximizing the margin dominates the conditional likelihood approach in terms of classification performance in most cases. Margin-optimized Bayesian network classifiers achieve classification performance comparable to support vector machines (SVMs) using fewer parameters. Moreover, we show that unanticipated missing feature values during classification can be easily processed by discriminatively optimized Bayesian network classifiers, a case where discriminative classifiers usually require mechanisms to complete unknown feature values in the data first.

10. F. Pernkopf and D. Bouchaffra, *"Genetic-based EM Algorithm for Learning Gaussian Mixture Models"*, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 27, No. 8, pp. 1344–1348, 2005.

    We propose a genetic-based expectation-maximization (GA-EM) algorithm for learning Gaussian mixture models from multivariate data. This algorithm is capable of selecting the number of components of the model using the minimum description length (MDL) criterion. Our approach benefits from the properties of Genetic algorithms (GA) and the EM algorithm by combination of both into a single procedure. The population-based stochastic search of the GA explores the search space more thoroughly than the EM method. Therefore, our algorithm enables escaping from local optimal solutions since the algorithm becomes less sensitive to its initialization. The GA-EM algorithm is elitist which maintains the monotonic convergence property of the EM algorithm.

## Publications

I contributed to more than 170 refereed conference papers (some at UAI, ICML, AISTATS, NIPS, ECML, AAAI, and ICASSP), 50 refereed journal papers (some at IEEE TPAMI, IEEE TSALP, PLOS One, IEEE TBME, JMLR, Pattern Recognition), and 2 book chapters. These papers received >4000 citations on Google Scholar and my h-index is 31.

### Book Chapter

1. F. Pernkopf, R. Peharz, S. Tschiatschek, *"Introduction to Probabilistic Graphical Models"*, Academic Press Library in Signal Processing, Vol. 1, Ch. 18, pp. 989-1064, 2014.
2. T. Nguyen, F. Pernkopf, *"Computational Lung Sound Classification: A Review"*, submitted, 2021.

### Journal Articles (peer-reviewed)

1. W. Roth, G. Schindler, B. Klein, R. Peharz, S. Tschiatschek, H. Fröning, F. Pernkopf, Z. Ghahramani, *"Resource-Efficient Neural Networks for Embedded Systems"*, JMLR, revised, 2021
2. N. Mutsam, F. Pernkopf, G. Lammer, *"Digital Optimization of Refractory Mainenance"*, Iron & Steel Technology, 2022.
3. A. Fuchs, J. Rock, M. Toth, P. Meissner and F. Pernkopf, *"Multi Antenna Radar Signal Denoising and Interference Mitigation using Complex-valued Convolutional Neural Networks"*, IEEE Transactions on Systems, Man and Cybernetics, Vol. pp. ,submitted, 2022, DOI:.
4. C. Obermair, T. Cartier-Michaud, A. Apollonio, L. Millar, L. Felsberger, L. Fischl, H.S. Bovbjerg, D. Wollmann, W. Wuensch, N. Catalan-Lasheras, M. Boronat, F. Pernkopf, G. Burt, *"Explainable Machine Learning for Breakdown Prediction in High Gradient RF Cavities"*, Physical Review Accelerators and Beams, Vol. 25, No. 10, 2022, DOI: 10.1103/PhysRevAccelBeams.25.104601.
5. T. Nguyen, F. Pernkopf, *"Lung Sound Classification Using Co-tuning and Stochastic Normalization"*, IEEE Transaction on Biomedical Engineering (TBME), Vol. 69, No. 9, pp. 2872-2882, 2022, DOI: 10.1109/TBME.2022.3156293..
6. L. Pfeifenberger, F. Pernkopf, *"Blind Speech Separation and Dereverberation using Neural Beamform-*

*ing"*, Speech Communication, Vol 140, pp. 29-41, 2022, DOI: https://doi.org/10.1016/j.specom.2022.03.004.
7. C. Knoll, A. Weller and F. Pernkopf, *"Self-Guided Belief Propagation – A Homotopy Continuation Method"*, IEEE Transactions on Pattern Analysis and Machine Intelligence, 2022, DOI: 10.1109/TPAMI.2022.3196
8. C. Knoll and F. Pernkopf, *"Belief Propagation: Accurate Marginals or Accurate Partition Function - - Where is the Difference?"*, Journal of Statistical Mechanics: Theory and Experiment, Vol. 2020, pp. 124009, 2020, DOI: 10.1088/1742-5468/abcaef.
9. J. Rock, W. Roth, M. Toth, P. Meissner and F. Pernkopf, *"Resource-efficient Deep Neural Networks for Automotive Radar Interference Mitigation"*, IEEE Journal of Selected Topics in Signal Processing, Vol. 15, pp. 927–940, 2021, DOI:10.1109/JSTSP.2021.3062452.
10. P. Aichinger, F. Pernkopf, *"Synthesis and Analysis-by-Synthesis of Modulated Diplophonic Glottal Area Waveforms"*, IEEE Transactions on Audio, Speech, and Language Processing, Vol. 29, pp. 914–926, 2021, DOI:10.1109/TASLP.2021.3053387.
11. L. Pfeifenberger, M. Zöhrer, W. Roth, G. Schindler, H. Fröning and F. Pernkopf, *Resource-Efficient Speech Mask Estimation for Multi-Channel Speech Enhancement*, arxiv.org, http://arxiv.org/abs/2007.11477, 2020.
12. A. Viertauer, N. Mutsam, F. Pernkopf, A. Gantner, G. Grimm, W. Winkler, R. Rössler, G. Lammer, A. Ratz, M. Persson *"Refractory Lifetime Prognosis for RH Degassers"*, Bulletin – The Journal of Refractory Innovations, 2020.
13. E. Messner, M. Fediuk, P. Swatek, S. Scheidl, F.-M. Smolle-Jüttner, H. Olschewski, F. Pernkopf, *"Multi-channel Lung Sound Classification with Convolutional Recurrent Neural Networks"*, Computers in Biology and Medicine, 2020, DOI: 10.1016/j.compbiomed.2020.103831.
14. N. Mutsam and F. Pernkopf, *"Tracking of a Gunning Jet Using Particle Filtering in Infrared Image Sequences"*, IEEE Transactions on Instrumentation and Measurements, Vol. 69, No. 9, pp. 6101–6111, 2020, DOI: 10.1109/TIM.2020.2972170.
15. L. Pfeifenberger, M. Zöhrer and F. Pernkopf, *"Eigenvector-based Speech Mask Estimation for Multi-Channel Speech Enhancement"*, IEEE Transactions on Audio, Speech, and Language Processing, pp. 2162-2172, 2019, DOI: 10.1109/TASLP.2019.2941592.
16. W. Roth and F. Pernkopf, *"Bayesian Neural Networks with Weight Sharing using Dirichlet Processes"*, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol.42, No. 1, pp. 246–252, 2020, DOI: 10.1109/TPAMI.2018.2884905
17. W. Roth, R. Peharz, S. Tschiatschek, F. Pernkopf, *"Hybrid Generative-Discriminative Training of Gaussian Mixture Models"*, Pattern Recognition Letters, Vol. 112, pp. 131–137, 2018, https://doi.org/10.1016/j.patrec
18. P. Aichinger, J. Schoentgen, F. Pernkopf, *"Detection of Extra Pulses in Synthesized Glottal Area Waveforms of Dysphonic Voices"*, Biomedical Signal Processing and Control, Vol. 50, pp.158–167 2018, https://doi.org/10.1016/j.bspc.2019.01.007
19. G. Lammer, A. Yaseen, R. Lanzenberger, A. Rom, A. Hanna, M. Forrer, M. Feuerstein, F. Pernkopf, N. Mutsam, *"Advanced Data Mining for Process Optimizations and Use of A.I. to Predict Refractory Wear and to Analyse Refractory Behavior"*, Iron & Steel Technology, 2018.
20. E. Messner, M. Zöhrer, F. Pernkopf, *"Heart Sound Segmentation - An Event Detection Approach using Deep Recurrent Neural Networks"*, IEEE Transaction on Biomedical Engineering (TBME), Vol. 65, No. 9, pp. 1964–1974, 2018, DOI: 10.1109/TBME.2018.2843258.
21. M. Ratajczak, S. Tschiatschek, and F. Pernkopf, *"Sum-Product Networks for Structured Prediction"*, https://arxiv.org/abs/1807.02324, 2018.
22. C.Knoll, D. Mehta, T.Chen, F. Pernkopf, *"Fixed Points of Belief Propagation - An Analysis via Polynomial Homotopy Continuation"*, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 40, No. 9, pp. 2124–2136, 2018, DOI: 10.1109/TPAMI.2017.2749575.
23. G. Lammer, R. Lanzenberger, A. Rom, A. Hanna, M. Forrer, M. Feuerstein, F. Pernkopf, N. Mutsam *"Digital Refractory Age"*, Bulletin – The Journal of Refractory Innovations, 2017.
24. P. Aichinger, M. Hagmüller, B. Schneider-Stickler, J. Schoentgen, F. Pernkopf, *"Tracking of Multiple*

*Fundamental Frequencies in Diplophonic Voices"*, IEEE Transactions on Audio, Speech, and Language Processing, Vol. 26, No. 2, pp. 330–341, 2018, DOI: 10.1109/TASLP.2017.2761233.
25. R. Peharz, R. Gens, F. Pernkopf, P. Domingos, *"On the Latent Variable Interpretation in Sum-Product Networks"*, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 39, No. 10, pp. 2030–2044, 2017, DOI: 10.1109/TPAMI.2016.2618381.
26. P.B. Marschik, F.B. Pokorny, R. Peharz, D. Zhang, J. OMuircheartaigh, H. Roeyers, S. Bölte, B. Urlesberger, W.E. Kaufmann, B. Schuller, L. Poustka, F. Pernkopf, T. Pock, K. Tammimies, C. Enzinger, M. Krieber, I. Tomantschger, K.D. Bartl-Pokorny, J. Sigafoos, M. Gugatschka, K. Nielsen-Saines, C. Einspieler, *"A Novel Way to Measure and Predict Development: A Heuristic Approach to Facilitate the Early Detection of Neurodevelopmental Disorders"*, Current Neurology Neuroscience Reports, 17:43, 2017
27. M. Krieber, K.D. Bartl-Pokorny, F.B. Pokorny, D. Zhang, K. Landerl, C. Körner, F. Pernkopf, T. Pock, C. Einspieler, P.B. Marschik, *"Eye movements during silent and oral reading in a regular orthography: Basic characteristics and correlations with childhood cognitive abilities and adolescent reading skills"*, PLOS One, 12(2), 2017.
28. P. Aichinger, M. Hagmüller, I. Roesner, W. Bigenzahn, B. Schneider-Stickler, J. Schoentgen, F. Pernkopf, *"Fundamental Frequency Tracking in Diplophonic Voices"*, Biomedical Signal Processing and Control, Vol. 37, pp 69–81, 2017.
29. N. Mutsam and F.Pernkopf, *"Maximum Margin Hidden Markov Models for Sequence Classification"*, Pattern Recognition Letters, Vol. 77, pp. 14–20, 2016.
30. M. Zöhrer, R. Peharz, and F. Pernkopf, *"Representation Learning for Single-Channel Source Separation and Bandwidth Extension"*, IEEE Transactions on Audio, Speech, and Language Processing, Vol. 23, No. 12 pp. 2398–2409, 2015.
31. S. Tschiatschek and F. Pernkopf, *"On Bayesian Network Classifiers with Reduced Precision Parameters"*, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 37, No. 4, pp. 774–785, 2015, DOI: 10.1109/TPAMI.2014.2353620.
32. C. Leitner and F. Pernkopf, *"On Pre-Image Iterations for Speech Enhancement"*, SpringerPlus, 2015.
33. M. Wohlmayr and F. Pernkopf, *"Model-Based Multiple Pitch Tracking Using Factorial HMMs: Model Adaptation and Inference"*, IEEE Transactions on Audio, Speech, and Language Processing, Vol. 21, No. 8, pp. 1742–1754, 2013, DOI: 10.1109/TASL.2013.2260744.
34. F. Pernkopf and M. Wohlmayr, *"Stochastic Margin-based Structure Learning of Bayesian Network Classifiers"*, Pattern Recognition, Vol. 46, No. 2, pp. 464–471, 2013.
35. R. Peharz and F. Pernkopf, *"Sparse Nonnegative Matrix Factorization with $\ell^0$ Constraints"*, Neurocomputing, vol. 80, pp. 38–46, March, 2012.
36. F. Pernkopf, M. Wohlmayr, S. Tschiatschek, *"Maximum Margin Bayesian Network Classifiers"*, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 34, No. 3, pp. 521–532, 2012, DOI: 10.1109/TPAMI.2011.149.
37. M. Wohlmayr, M.Stark, and F. Pernkopf, *"A Probabilistic Interaction Model for Multipitch Tracking With Factorial Hidden Markov Models"*, IEEE Transactions on Audio, Speech, and Language Processing, Vol. 19, No. 4, pp. 799–810, 2011.
38. M. Stark, M. Wohlmayr, and F. Pernkopf, *"Source-Filter based Single Channel Speech Separation using Pitch Information"*, IEEE Transactions on Audio, Speech, and Language Processing, Vol. 19, No. 2, pp. 242–255, 2011.
39. F. Pernkopf and J. Bilmes, *"Efficient Heuristics for Discriminative Structure Learning of Bayesian Network Classifiers"*, Journal of Machine Learning Research, Vol. 11, pp. 2323–2360, 2010.
40. S. Petrik, C. Drexel, L. Fessler, J. Jancsary, A. Klein, G. Kubin, J. Matiasek, F. Pernkopf, H. Trost, *"Semantic and Phonetic Automatic Reconstruction of Medical Dictations"*, Computer Speech & Language, Vo. 25, No. 2, pp. 363–385, 2011.
41. C. Tantibundhit, F. Pernkopf, and G. Kubin, *"Joint*

*Time-Frequency Segmentation Algorithm for Transient Speech Decomposition and Speech Enhancement"*, IEEE Transactions on Audio, Speech, and Language Processing, Vol. 18, No. 6, pp. 1417–1428, 2010.

42. F. Pernkopf, *"Tracking of Multiple Targets Using On-line Learning for Appearance Model Adaptation"*, IEEE Transactions on Systems, Man, and Cybernetics: Part B, Vol. 38, No. 6, pp. 1465–1475 , 2008.
43. F. Pernkopf, T. V. Pham, and J. Bilmes, *"Broad Phonetic Classification Using Discriminative Bayesian Networks"*, Speech Communication, Vol. 51, No. 2, pp. 151–166, 2009.
44. F. Pernkopf, *"3D Surface Analysis Using Coupled HMMs"*, Machine Vision and Applications, Vol. 16, No. 5, pp. 298–305, 2005.
45. F. Pernkopf, *"3D Surface Acquisition and Reconstruction for Inspection of Raw Steel Products"*, Computers in Industry, Vol. 56, pp. 876–885, 2005.
46. F. Pernkopf and D. Bouchaffra, *"Genetic-based EM Algorithm for Learning Gaussian Mixture Models"*, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 27, No. 8, pp. 1344–1348, 2005, DOI: 10.1109/TPAMI.2005.162.
47. F. Pernkopf, *"Bayesian Network Classifiers versus Selective $k$-NN Classifiers"*, Pattern Recognition, Vol. 38, No. 1, pp. 1–10, 2005.
48. F. Pernkopf, *"Detection of Surface Defects on Raw Steel Blocks Using Bayesian Network Classifiers"*, Pattern Analysis and Applications, Vol. 7, No. 3, pp. 333–342, 2004.
49. F. Pernkopf and P. O'Leary, *"Floating Search Algorithm for Structure Learning of Bayesian Network Classifiers"*, Pattern Recognition Letters, Vol. 24, pp. 2839–2848, 2003.
50. F. Pernkopf and P. O'Leary, *"Image Acquisition Techniques for Automatic Visual Inspection of Metallic Surfaces"*, NDT&E International, Vol. 36, No. 8, pp. 609–617, 2003.
51. F. Pernkopf and P. O'Leary, *"Visual Inspection of Machined Metallic High-Precision Surfaces"*, Eurasip Journal on Applied Signal Processing, Vol. 2002, No. 7, pp. 667–678, 2002.

## Conference Articles (peer-reviewed)

1. H. Bradl, M. Huber, F. Pernkopf, *"Transfer Learning Using Musical/Non-Musical Mixtures for Multi-Instrument Recognition"*, Interspeech 2023, submitted.
2. C. Toth, L. Lorch, C. Knoll, A. Krause, F. Pernkopf, R. Peharz, J. von Kügelgen *"Active Bayesian Causal Inference"*, NeurIPS, 2022.
3. A. Fuchs, C. Knoll, E. Leitinger, F. Pernkopf, *"Self-attention for enhanced OAMP Detection in MIMO Systems"*, ICASSP 2023.
4. J. Möderl, E. Leitinger, F. Pernkopf, K. Witrisal, *"Variational Message Passing-based Respiratoiry Motion Estimation and Detection Using Radar Signals"*, ICASSP, 2023.
5. M. Hirschmugl, J. Rock, P. Meissner and F. Pernkopf, *"Fast and Resource-Efficient CNNs for Radar Interference Mitigation on Embedded Hardware"*, Euopean Radar Conference, accepted, 2022.
6. B. Schuppler, E. Berger, X. Kogler, F. Pernkopf, *"Homophone Disambiguation Profits from Durational Information"*, Interspeech, accepted, 2022.
7. C. Obermair, A. Fuchs, L. Felsberger, F. Pernkopf, A. Apollonio and D. Wollmann, *"Example or Prototype? Learning Concept-Based Explanations in Time Series"*, Asian Conference on Machine Learning (ACML), accepted, 2022.
8. H. Leisenberger, F. Pernkopf and C. Knoll *"Fixing the Bethe Approximation: How Structural Modifications in a Graph Improve Belief Propagation"*, UAI, accepted, 2022.
9. D. Peter, W. Roth and F. Pernkopf, *"End-to-end Keyword Spotting using Neural Architecture Search and Quantization"*, ICASSP, accepted, 2022.
10. A. Fuchs, C. Knoll, F. Pernkopf, *"Wasserstein Distribution Correction for Improved Robustness in Deep Neural Networks"*, NeurIPS Workshop DistShift, accepted, 2021.
11. J. Möderl, F. Pernkopf, K. Witrisal, *"Car Occupant Detection using Ultra-Wideband Radar"*, European Radar Conference, 2022, submitted.
12. J. Möderl, F. Pernkopf, K. Witrisal, *"Car Occupant Detection using Ultra-Wideband Radar"*, Cost

Action CA15103 TD(21), 2021.

13. N. Mutsam, F. Pernkopf, G. Lammer, *"Digital Optimization of Refractory Maintenance"*, AISTech – The Iron & Steel Technology Conference and Exposition, 2021.
14. H. Leisenberger, C. Knoll, R. Seeber and F. Pernkopf, *"Convergence Behavior of Belief Propagation: Estimating Regions of Attraction via Lyapunov Functions"*, UAI, accepted, 2021.
15. A. Fuchs, J. Rock, M. Toth, P,. Meissner, F. Pernkopf, *"Complex-Valued Convolutional Neural Networks for Enhanced Radar Signal Denoising and Interference Mitigation"*, IEEE Radar Conference, accepted, 2021.
16. S. Fragner, T. Topar, M. Giller, L. Pfeifenberger, F. Pernkopf, *"Autonomous Robot for Measuring Room Impulse Responses"*, Show & Tell, Interspeech, 2021.
17. L. Pfeifenberger, M. Zöhrer and F. Pernkopf, *"Acoustic Echo Cancellation with Cross-Domain Learning"*, Interspeech, accepted, 2021.
18. T. Nguyen, F. Pernkopf, *Crackle Detection In Lung Sounds Using Transfer Learning And Multi-Input Convolitional Neural Networks"*, IEEE Engineering in Medicine and Biology Society (EMBC), accepted, 2021.
19. C. Obermair, A. Apollonio, Z. Charifoulline, M. Maciejewski, F. Pernkopf and A. Verweij, *"Machine Learning with a Hybrid Monitoring of the Protection Systems of the LHC"*, International Particle Accelerator Conference (IPAC), 2021, DOI: 10.18429/JACoW-IPAC2021-MOPAB345.
20. C. Obermair, A. Apollonio. T. Cartier-Michaud, N. Catalan-Lasheras, L. Felsberger, W.L. Millar, F. Pernkopf, W. Wuensch, , *"Machine Learning Models for Breakdown Prediction in RF Cavities for Accelerators"*, International Particle Accelerator Conference (IPAC), 2021, DOI: 10.18429/JACoW-IPAC2021-MOPAB344.
21. W.Roth, G. Schindler, H. Fröning and F. Pernkopf *"Resource-efficient Bayesian Network Classifiers: Quantization and TAN Structure Learning"*, International Conference on Pattern Recognition (ICPR), pp. 10297–10304 , 2021, DOI: 10.1109/ICPR48806.2021.9413156.
22. D. Peter, W.Roth and F. Pernkopf, *"Resource-efficient DNNs for Keyword Spotting using Neural Architecture Search an Quantization"*,International Conference on Pattern Recognition (ICPR), pp. 9273–9279, 2021, DOI:10.1109/ICPR48806.2021.9413191.
23. J. Rock, W.Roth, P. Meissner and F. Pernkopf, *"Quantized Deep Neural Networks for Radar Interference Mitigation"*,ECML, ITEM Workshop, accepted, 2020.
24. W.Roth and F. Pernkopf, *"Differentiable TAN Structure Learning for Bayesian Networks"*, International Conference on Probabilistic Graphical Models, accepted, 2020.
25. G. Schindler, W.Roth, F. Pernkopf and H. Fröning, *"Parameterized Structured Pruning for Deep Neural Networks"*, Machine Learning, Optimization, and Data Science (LOD), accepted, 2020.
26. L. Pfeifenberger and F. Pernkopf, *"Nonlinear Residual Echo Suppression using a Recurrent Neural Network"*, Interspeech, pp. 3950–3954, 2020, DOI:10.21437/Interspeech.2020-1473.
27. T. Nguyen, F. Pernkopf, *"Lung Sound Classification Using Snapshopt Ensemble of Convolutional Neural Networks"*, IEEE Engineering in Medicine and Bilogy Society (EMBC), accepted, 2020.
28. A. Fuchs, R. Priewald, F. Pernkopf *Laser-based Hair Crack Detection on Wafers*, accepted, 2020.
29. M. Huber, G. Schindler, W. Roth, H. Fröning, Schörkhuber, F. Pernkopf, *Towards Real-Time Single-Channel Singing-Voice Separation with Pruned Multi-Scaled DenseNets*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), 2020, DOI: 10.1109/ICASSP40776.2020.9053542.
30. T. Nguyen, M. Kosmider, F. Pernkopf, *Acoustic Scene Classification for Mismatched Recording Devices Using Heated-Up Softmax and Spectrum Correction*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), accepted, 2020.
31. P. Gabler, M. Trapp, H. Ge, F. Pernkopf, *"Graph Tracking in Dynamic Probabilistic Programs via Source Transformations"*, Symposium on Advances in Approximate Bayesian Inference (AABI), 2019.
32. M. Trapp, R. Peharz, F. Pernkopf, and C.E. Rasmussen, *"Deep Structured Mixtures of Gaussian Processes"*, AISTATS, accepted, 2020.

33. C. Knoll, F. Pernkopf, *"Guided Selection of Accurate Belief Propagation Fixed Points"*, NeurIPS, Workshop on Machine Learning and the Physical Sciences, 2019.
34. A. Fuchs, R. Priewald, F. Pernkopf, *"Recurrent Dilated DenseNets for a Time-Series Segmentation Task"*, IEEE International Conference on Machine Learning and Applications, 2019, DOI: 10.1109/ICMLA.2019.00021.
35. J. Rock, M. Toth, P. Meissner and F. Pernkopf, *"CNNs for Interference Mitigaton and Denoising in Automotive Radar Using Real World Data"*, NeurIPS Workshop on Machine Learning for Autonomous Driving, 2019.
36. T. Nguyen A. Fuchs and F. Pernkopf, *"Acoustic Scene Classification Using Deep Mixture of Pre-trained Convolutional Neural Networks"*, IEEE International Conference on Machine Learning and Applications, 2019, DOI: 10.1109/ICMLA.2019.00151.
37. M. Trapp, R. Peharz, H. Ge, F. Pernkopf, and Z. Ghahramani, *"Bayesian Learning of Sum-Product Networks"*, NeurIPS, 2019.
38. M. Trapp, R. Peharz, and F. Pernkopf, *"Optimization of Overparameterized Sum-Product Networks"*, International Conference on Machine Learning (ICML); Workshop on Tractable Probabilistic Models, 2019.
39. A. Viertauer, N. Mutsam, F. Pernkopf, A. Gantner, G. Grimm, W. Winkler, G. Lammer, A. Ratz, M. Persson *"Refractory Lifetime Prognosis for RH-Degassers"*, UNITECR, 2019.
40. W. Roth, G. Schindler, H. Fröning and F. Pernkopf, *"Training Discrete-Valued Neural Networks with Sign Activations Using Weight Distributions"*, European Conference on Machine Learning (ECML), 2019, DOI: https://doi.org/10.1007/978-3-030-46147-8_23
41. T. Nguyen and F. Pernkopf, *"Acoustic Scene Classification with Mismatched Devices Using CliqueNets and Mixup Data Augmentation"*, Interspeech, 2019.
42. J. Rock, M. Toth, E. Messner, P. Meissner and F. Pernkopf, *"Complex Signal Denoising for Automotive Radar using Convolutional Neural Networks"*, FUSION, 2019.
43. C. Knoll and F. Pernkopf, *"Belief Propagation: Accurate Marginals or Accurate Partition Function - Where is the Difference?"*, UAI, 2019.
44. B.K.Aichernig, R. Bloem, M. Ebrahimi, M. Horn, F. Pernkopf, W. Roth, A. Rupp, M. Tappler, M. Tranninger, *"Learning a Behavior Model of Hybrid Systems through Combining Model-Based Testing and Machine Learning"*, IFIP-ICTSS, 2019, https://doi.org/10.1007/978-3-030-31280-0_1.
45. T. Nguyen and F. Pernkopf, *"Acoustic Scene Classification with Mismatched Recording Devices Using Mixture of Experts Layers"*, IEEE International Conference on Multimedia and Expo (ICME), 2018, DOI: 10.1109/ICME.2019.00287.
46. P. Aichinger, I, Roesner, F. Pernkopf, J. Schoentgen, *"Glottal Area Waveform Modeling based Voice Quality Typing"*, International Conference on Advances in Quantitative Laryngology, Voice and Speech Research, 2019.
47. B.K. Aichernig, F. Pernkopf, R. Schumi, A. Wurm, *Predicting and Testing Latencies with Deep Learning: An IoT Case Study*, TAP, 2019.
48. A. Viertauer, N. Mutsam, F. Pernkopf, A. Gantner, G. Grimm, W. Winkler, G. Lammer, A. Ratz, *"Refractory Condition Monitoring an dLifetime Prognosis for RH Degasser"*, AISTech – The Iron & Steel Technology Conference and Exposition, 2019, DOI 10.1000.377.111.
49. L. Pfeifenberger, M. Zöhrer, F. Pernkopf, *"Deep Complex-valued Neural Beamformers"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), 2019, DOI: 10.1109/ICASSP.2019.86835
50. M. Trapp, R. Peharz, C.E. Rassmusen and F. Pernkopf, *"Learning Deep Mixtures of Gaussian Process Experts Using Sum-Product Networks"*, International Conference on Machine Learning (ICML); Workshop on Tractable Probabilistic Models, https://arxiv.org/abs/1809.04400, 2018.
51. E. Messner, M. Fediuk, P. Swatek, S. Scheidl, F.-M. Smolle-Jüttner, H. Olschewski, F. Pernkopf, *"Crackle and Breathing Phase Detection in Lung Sounds with Deep Bidirectional Gated Recurrent Neural Networks"*, IEEE Engineering in Medicine and Bilogy Society (EMBC), 2018, DOI: 10.1109/EMBC.2018.851223

52. T.K.T. Nguyen and F. Pernkopf, *"Acoustic Scene Classification Using A Convolutional Neural Network Ensemble and Nearest Neighbor Filters"*, Workshop on Detection and Classification of Acoustic Scenes and Events, 2018.
53. H. Unterholzner, L. Pfeifenberger, F. Pernkopf, M. Matassoni, A. Brutti and D. Falavigna, *"Channel-Selection for Distant-Speech Recognition on CHiME-5 Dataset"*, CHiME-5 Workshop, 2018.
54. R. Harb and F. Pernkopf, *"Sound Event Detection Using Weakly Labeled Semi-Supervised Data with GCRNNs, VAT, and self-adaptive label refinement"*, Workshop on Detection and Classification of Acoustic Scenes and Events, 2018.
55. G. Schindler, M. Zöhrer, F. Pernkopf, H. Fröning, *"Towards Efficient Forward Propagation on Resource-Constrained Systems"*, European Conference on Machine Learning (ECML), 2018, DOI: https://doi.org/10.1007/978-3-030-10925-7_26.
56. P. Aichinger, I, Roesner, F. Pernkopf, J. Schoentgen, *"Auditory Discrimination of Different Types of Sonified Synthesized Glottal Area Waveforms"*, International Conference on Voice Physiology and Biomechanics (ICVPB),2018.
57. T. Schrank and F. Pernkopf, *"Automatic clustering of a network protocol with weakly-supervised clustering"*, Workshop LearnAut, submitted, 2018.
58. M. Zöhrer, L. Pfeifenberger, G. Schindler, H. Fröning, F. Pernkopf, *"Resource Efficient Deep Eigenvector Beamforming"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), 2018.
59. P. Aichinger, I. Roesner, J. Schoentgen, F. Pernkopf, *"Modelling of Random Extra Pulses During Quasi-Closed Glottal Cycle Phases"*, MAVEBA, 2017.
60. C. Knoll and F. Pernkopf, *"On Loopy Belief Propagation – Local Stability Analysis for Non-Vanishing Fields"*, Uncertainty in Artificial Intelligence (UAI), 2017.
61. M. Trapp, T.Madl, R. Peharz, F. Pernkopf and R. Trappl, *"Safe Semi-Supervised Learning of Sum-Product Networks"*, Uncertainty in Artificial Intelligence (UAI), 2017.
62. L. Pfeifenberger, M. Zöhrer and F. Pernkopf, *"Eigenvector-based Speech Mask Estimation using a Logistic Regression for Multi-Channel Speech Enhancement"*, Interspeech, 2017.
63. M. Ratajczak, S. Tschiatschek and F. Pernkopf, *"Frame and Segment Level Recurrent Neural Networks for Phone Classification"*, Interspeech, 2017.
64. M. Zöhrer and F. Pernkopf, *"Virtual Adversarial Training and Data Augmentation for Acoustic Event Detection with Gated Recurrent Neural Networks"*, Interspeech, 2017.
65. G. Lammer, A. Yaseen, R. Lanzenberger, A. Rom, A. Hanna, M. Forrer, M. Feuerstein, F. Pernkopf, N. Mutsam, *"Advanced Data Mining for Process Optimizations and Use of A.I. to Predict Refractory Wear and to Analyse Refractory Behavior"*, AISTech – The Iron & Steel Technology Conference and Exposition, 2017.
66. E. Messner, M. Hagmüller, P. Swatek, F.-M. Smolle-Jüttner, F. Pernkopf, *"Respiratory Airflow Estimation from Lung Sounds Based on Regression"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), 2017.
67. L. Pfeifenberger, M. Zöhrer, F. Pernkopf, *"DNN-based Speech Mask Estimation for Eigenvector Beamforming"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), 2017.
68. E. Messner, M. Hagmüller, P. Swatek, F. Pernkopf, *"Impact of Airflow Rate on Amplitude and Regional Distribution of Normal Lung Sounds"*, BIOSIGNALS, 2017.
69. C.Knoll, F. Pernkopf, D. Mehta, T.Chen, *"Fixed Points Solutions of Belief Propagation"*, Neural Information Processing Systems (NIPS) workshop, 2016.
70. W. Roth and F. Pernkopf, *"Variational Inference in Neural Networks using an Approximate Closed-Form Objective"*, Neural Information Processing Systems (NIPS) workshop, 2016.
71. M. Trapp, R. Peharz, M. Skowron, T. Madl, F. Pernkopf and R. Trappl, *"Structure Inference in Sum-Product Networks using Infinite Sum-Product Trees"*, Neural Information Processing Systems

(NIPS) workshop, 2016.

72. T. Schrank, L. Pfeifenberger, M. Zöhrer, J. Stahl, P. Mowlaee, F. Pernkopf, *"Deep Beamforming and Data Augmentation for Robust Speech Recognition: Results of the 4$^{th}$ CHiME Challenge"*, CHiME 4 Workshop, 2016.
73. M. Zöhrer and F. Pernkopf, *"Gated Recurrent Networks applied to Acoustic Scene Classification"*, Eusipco, 2016.
74. F.B. Pokorny, B.W. Schuller, R. Peharz, F. Pernkopf, K.D.Bartl-Pokorny, C. Einspieler, P.B. Marschik, *"Retrospektive Analyse frühkindlicher Lautäußerungen in "Home-Videos": Ein signalanalytischer Ansatz zur Früherkennung von Entwicklungsstörungen"*, Österreichische Linguistiktagung (ÖLT42), 2016.
75. T. Schrank, F. Röck, M. Tappler, F. Pernkopf, R. Bloem, B. Aichernig *"Poster: Learning Models of a Network Protocol using Neural Network Language Models"*, IEEE Symposium on Security and Privacy, 2016.
76. F.B. Pokorny, B.W. Schuller, R. Peharz, F. Pernkopf, K.D.Bartl-Pokorny, C. Einspieler, P.B. Marschik, *"Contributing to the early identification of neurodevelopmental disorders: The retrospective analysis of pre-linguistic vocalisations in home video material"*, Congreso Internacional Psicologia Clinica, abstract, 2016.
77. F.B. Pokorny, R. Peharz, W. Roth, M. Zöhrer, F. Pernkopf, P.B. Marschik, B.W. Schuller, *"Manual Versus Automated: The Challenging Routine of Infant Vocalisation Segmentation in Home Videos to Study Neuro(mal)development"*, Interspeech, 2016.
78. M. Ratajczak, S. Tschiatschek and F. Pernkopf, *"Virtual Adversarial Training Applied to Neural Higher-Order Factors for Phone Classification"*, Interspeech, 2016.
79. J. Fahringer, T. Schrank, J. Stahl. P. Mowlaee, and F. Pernkopf, *"Phase-Aware Processing for Automatic Speech Recognition"*, Interspeech, 2016.
80. E. Messner, M. Hagmüller, P. Swatek, F. Pernkopf, *"A Robust Multichannel Lung Sound Recording Device"*, Biodevices, 2016.
81. L. Pfeifenberger, T. Schrank, M. Zöhrer, Martin Hagmüller, F. Pernkopf, *"Multi-channel speech processing architectures for noise robust speech recognition: 3$^{rd}$ CHiME Challenge results"*, ASRU Workshop, 2015
82. F.B. Pokorny, F. Graf, F. Pernkopf and B.W. Schuller, *"Detection of Negative Emotions in Speech Signals Using Bags-of-Audio-Words"*, Intern. Workshop on Automatic Sentiment Analysis in the Wild - part of Intern. Conf. on Affective Computing and Intelligent Interaction (ACII), 2015
83. S. Tschiatschek and F. Pernkopf, *"Generatively Optimized Bayesian Network Classifiers Under Computational Constraints"*, International Conference on Machine Learning (ICML), Workshop on Resource-Efficient Machine Learning, 2015.
84. C. Knoll, M. Rath, S. Tschiatschek, F. Pernkopf, *"Analysis of Message Scheduling for Belief Propagation"*, European Conference on Machine Learning (ECML), 2015.
85. M. Ratajczak, S. Tschiatschek, F. Pernkopf, *"Structured Regularizer for Neural Higher-Order Sequence Models"*, European Conference on Machine Learning (ECML), 2015.
86. S. Tschiatschek, F. Pernkopf, *"Learning of Bayesian Network Classifiers Under Computational Constraints"*, European Conference on Machine Learning (ECML), 2015.
87. P. Aichinger, M. Hagmüller, I. Roesner, W. Bigenzahn, B. Schneider-Stickler, J. Schoentgen, F. Pernkopf, *"Measurement of Fundamental Frequencies in Diplophonic Voice"*, MAVEBA, 2015.
88. M. Ratajczak, S. Tschiatschek and F. Pernkopf, *"Neural Higher-Order Factors in Conditional Random Fields for Phoneme Classification"*, Interspeech, 2015.
89. M. Zöhrer, R. Peharz, and F. Pernkopf, *"On Representation Learning for Artificial Bandwidth Extension"*, Interspeech, 2015.
90. R. Peharz, S. Tschiatschek, F. Pernkopf and P.Domingos, *"On theoretical properties of sum-product networks"*, AISTATS, 2015.
91. M. Zöhrer and F. Pernkopf, *"Representation Models in Single Channel Source Separation"*, IEEE

International Conference on Acoustics, Speech, and Signal Processing (ICASSP), 2015.

92. M. Zöhrer, F. Pernkopf, *"General Stochastic Networks for Classification"*, Neural Information Processing Systems (NIPS), 2014.
93. S. Tschiatschek, K. Paul, F. Pernkopf, *"Integer Bayesian Networks"*, European Conference on Machine Learning (ECML), pp. 209–224, 2014.
94. M. Ratajczak, S. Tschiatschek and F. Pernkopf, *"Context-Specific Deep Conditional Random Fields for Structured Prediction"*, International Conference on Machine Learning (ICML), Workshop on Learning Tractable Probabilistic Models, 2014.
95. F. Pokorny, F. Graf, and F. Pernkopf, *"Erkennung negativer Emotionen in Sprachsignalen mittels Bags-of-Audio-Words"*, DAGA, 2014.
96. M. Wohlmayr, L. Mohr, F. Pernkopf, *"On Self-Adaptation in Single-Channel Source Separation"*, Interspeech, 2014.
97. M. Zöhrer, F. Pernkopf, *"Single-Channel Source Separation with General Stochastic Networks"*, Interspeech, 2014.
98. L. Pfeifenberger, F. Pernkopf, *"Blind Source Extraction Based on a Direction-Dependent A-Priori SNR"*, Interspeech, 2014.
99. L. Pfeifenberger, F. Pernkopf, *"A Multi-channel Postfilter based on the Ideal Diffuse Sound Field"*, EUSIPCO, 2014.
100. C. Leitner, J.A.M. Cordovilla, F. Pernkopf, *"Evaluation of Speech Enhancement Based on Pre-Image Iterations Using Automatic Speech Recognition"*, EUSIPCO, 2014.
101. A. Zehetner, M. Hagmüller, and F. Pernkopf, *"Wake-Up-Word Spotting for Mobile Systems"*, EUSIPCO, 2014.
102. R. Peharz, G. Kapeller, P. Mowlaee, and F. Pernkopf, *"Modeling Speech with Sum-Product Networks: Application to Bandwidth Extension"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 3699 – 3703, 2014.
103. R. Peharz, B. Geiger, F. Pernkopf, *"Greedy Part-wise Learning of Sum-Product Networks"*, European Conference on Machine Learning (ECML), LNCS, pp. 612–627, 2013.
104. P. Mowlaee, J.A.M. Cordovilla, F. Pernkopf, H. Pessentheiner, M. Hagmüller, G. Kubin, *"The 2nd CHiME Speech Separation and Recognition Challenge: Approaches on Single-Channel Speech Separation and Model-Driven Speech Enhancement"*, Post-ICASSP Workshop, 2013.
105. S. Tschiatschek, C.E. Cancione Chacón, and F. Pernkopf, *"Bound for Bayesian Network Classifiers with Reduced Precision Parameters"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 3357 – 3361, 2013.
106. C. Leitner and F. Pernkopf, *"Generalization of Pre-Image Iterations for Speech Enhancement"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 7010–7014, 2013.
107. M. Wohlmayr and F. Pernkopf, *"Model Adaptation of Factorial HMMs for Multipitch Tracking"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 6792–6796, 2013.
108. S. Tschiatschek and F. Pernkopf, *"Asymptotic Optimality of Maximum Margin Bayesian Networks"*, AISTATS, pp. 590–598 2013.
109. R. Peharz, S. Tschiatschek, F. Pernkopf, *"The Most Generative Maximum Margin Bayesian Networks"*, International Conference on Machine Learning (ICML), JMLR C&WP Vol. 28. No. 3, pp. 235 – 243, 2013.
110. Morales-Cordovilla, J. A., H. Pessentheiner, M. Hagmüller, P. Mowlaee, F. Pernkopf, and G. Kubin, *"A German distant speech recognizer based on 3D beamforming and harmonic missing data mask"*, AIA-DAGA, 2013.
111. S. Tschiatschek, N. Mutsam, F. Pernkopf, *"Handling Missing Features in Maximum Margin Bayesian Network Classifiers"*, IEEE Workshop on Machine Learning for Signal Processing, 2012.
112. C. Leitner and F. Pernkopf, *"Extension of Pre-Image Speech De-Noising by Voice Activity Detection Using a Bone-Conductive Microphone"*, IWAENC, 2012.

113. S. Tschiatschek, P. Reinprecht, M. Mücke, F. Pernkopf, *"Discriminative Bayesian Network Classifiers with Reduced Precision Parameters"*, European Conference on Machine Learning (ECML), LNCS 7523, pp.74–89, 2012.
114. R. Peharz and F. Pernkopf, *"Exact Maximum Margin Structure Learning of Bayesian Networks"*, International Conference on Machine Learning (ICML), 2012.
115. C. Leitner and F. Pernkopf, *"Suppression of Musical Noise in Enhanced Speech Using Pre-Image Iterations"*, EUSIPCO, 2012.
116. C. Leitner and F. Pernkopf, *"Musical Noise Suppression for Speech Enhancement using Pre-Image Iterations"*, International Conference on Systems, Signals and Image Processing (IWSSIP), pp. 464–467 , 2012.
117. C. Leitner and F. Pernkopf, *"Speech Enhancement using Pre-image Iterations"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 4665–4668, 2012.
118. R. Peharz and F. Pernkopf, *"On linear and MIXMAX Interaction models for Single Channel Source Separation"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP),pp. 249–252, 2012.
119. S. Tschiatschek and F. Pernkopf, *"Convex Combinations of Maximum Margin Bayesian Network Classifiers"*, International Conference on Pattern Recognition Applications and Methods (ICPRAM), 2012.
120. C. Leitner, F. Pernkopf, *"The Pre-Image Problem and Kernel PCA for Speech Enhancement"*, Non Linear Speech Processing (NoLISP), pp. 199–206, 2011.
121. M. Wohlmayr and F. Pernkopf, *"EM-based Gain Adaptation for Probabilistic Multipitch Tracking"*, Interspeech, pp. 1969–1972, 2011.
122. G. Pirker, M. Wohlmayr, S. Petrik, and F. Pernkopf, *"A Pitch Tracking Corpus with Evaluation on Multipitch Tracking Scenario"*, Interspeech, pp. 1509–1512, 2011.
123. C. Leitner, F. Pernkopf, and G. Kubin, *"Kernel PCA for Speech Enhancement"*, Interspeech, pp. 1221–1224, 2011.
124. R. Peharz, M. Wohlmayr, and F. Pernkopf, *"Gain-robust Multi-pitch Tracking Using Sparse Nonnegative Matrix Factorization"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 5416–5419, 2011.
125. M. Wohlmayr, R. Peharz, and F. Pernkopf, *"Efficient Implementation of Probabilistic Multi-pitch Tracking"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 5412–5415, 2011.
126. F. Pernkopf, M. Wohlmayr, and M. Mücke, *"Maximum Margin Structure Learning of Bayesian Network Classifiers"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 2076–2079, 2011.
127. R. Peharz, M. Stark, F. Pernkopf, Yannis Stylianou, *"A factorial sparse coder model for single channel source separation"*, Interspeech, pp. 386–389, 2010.
128. R. Peharz, M. Stark, F. Pernkopf, *"Sparse Nonnegative Matrix Factorization using $\ell^0$ Constraints"*, IEEE International Workshop on Machine Learning for Signal Processing, pp. 83–88, 2010.
129. M. Stark, M. Wohlmayr, F. Pernkopf, *"Single Channel Speech Separation Using Source-Filter Representation"*, International Conference on Pattern Recognition (ICPR), pp. 826-829, 2010.
130. F. Pernkopf, M. Wohlmayr, *"Maximum Margin Training for Gaussian Mixture Models with Application to Multipitch Tracking"*, International Conference on Computational Statistics (COMPSTAT), 2010.
131. F. Pernkopf, M. Wohlmayr, *"Large Margin Learning of Bayeian Classifiers based on Gaussian Mixture Models"*, European Conference on Machine Learning (ECML), pp. 50-66, 2010.
132. M. Wohlmayr, M. Stark, F. Pernkopf, *"A Mixture Maximization Approach to Multipitch Tracking With Factorial Hidden Markov Models"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 5070 – 5073, 2010.
133. M. Stark, F. Pernkopf, *"On Optimizing the Computational Complexity for VQ-Based Single Channel*

*Source Separation"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 237–240, 2010.

134. M. Wohlmayr, F. Pernkopf, *"Finite Mixture Spectrogram Modeling for Multipitch Tracking Using A Factorial Hidden Markov Model"*, Interspeech, pp. 1079–1082, 2009.
135. M. Wiesenegger, F. Pernkopf, *"Wavelet-Based Speaker Change Detection in Single Channel Speech Data"*, Interspeech, pp. 836–839, 2009.
136. F. Pernkopf, M. Wohlmayr, *"On Discriminative Parameter Learning of Bayesian Network Classifiers"*, European Conference on Machine Learning (ECML), pp. 221–237, 2009.
137. C. Kranzler, F. Pernkopf, R. Muhr, M. Pucher, F. Neubarth, *"Text-To-Speech Engine with Austrian German Corpus"*, International Conference on Speech and Computer (SPECOM), 2009.
138. M. Stark, F. Pernkopf, *"A Dictionary Based Noise Robust Single Pitch Tracker"*, International Conference on Speech and Computer (SPECOM), 2009.
139. M. Stark, F. Pernkopf, *"Towards Source-Filter Based Single Sensor Speech Separation"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 97–100, 2009.
140. C. Tantibundhit, F. Pernkopf, G. Kubin, *"Speech Enhancement Based on Joint Time-Frequency Segmentation"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 4673–4676, 2009.
141. C. Boehm, F. Pernkopf, *"Effective Metric-Based Speaker Segmentation in the Frequency Domain"*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 4081–4084, 2009.
142. M. Wohlmayr, F. Pernkopf, *"Multipitch Tracking Using A Factorial Hidden Markov Model"*, Interspeech, pp. 147–150, 2008.
143. T.V. Pham, M. Stadtschnitzer, F. Pernkopf, G. Kubin, *"Voice Activity Detection Algorithms Using Subband Power Distance Feature For Noisy Environments"*, Interspeech, pp. 2586–2589, 2008.
144. M. Stark, F. Pernkopf, T. V. Pham, and G. Kubin, *"Vocal-Tract Modeling for Speaker Independent Single Channel Source Separation"*, Workshop on Cognitive Information Processing, pp. 217–220, 2008.
145. S. Petrik and F. Pernkopf, *"Language Model Adaptation for Medical Dictations by Automatic Phonetics-Driven Transcript Reconstruction"*, IASTED International Conference on Artificial Intelligence and Applications, pp. 194–199, 2008.
146. S. Petrik and F. Pernkopf, *"Automatic Phonetics-Driven Reconstruction of Medical Dictations on Multiple Levels of Segmentation"*, International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 4317–4320, 2008.
147. S. Petrik and F. Pernkopf, *"Automatic Phonetics-Driven Reconstruction of Medical Dictations on Multiple Levels of Segmentation"*, International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 4317–4320, 2008.
148. F. Pernkopf, *"Multiple Object Tracking Using Incremental Learning for Appearance Model Adaptation"*, International Conference on Computer Vision Theory and Applications, pp. 463–468, 2008.
149. F. Pernkopf and J. Bilmes, *"Order-based Discriminative Structure Learning for Bayesian Network Classifiers"*, International Symposium on Artificial Intelligence and Mathematics, 2008.
150. F. Pernkopf, *"Tracking of Multiple Targets Using On-line Learning for Appearance Model Adaptation"*, International Conference on Image Analysis and Recognition (ICIAR), pp. 602–614, 2007.
151. V. Denchev, F. Pernkopf, D. Radev, *"Modeling and Clustering Analysis of Broadband Convergence Networks"*, IEEE International Workshop on Broadband Convergence Networks, pp. 1–12, 2007.
152. M. Kepesi, M. Wohlmayr, and F. Pernkopf, *"Joint position-pitch tracking for 2-channel audio"*, International Workshop on Content-Based Multimedia Indexing, pp. 303–306, 2007.
153. M. Neffe, T.V. Pham, F. Pernkopf, and G. Kubin, *"Robust Speaker Verification in Air Traffic Control Using Improved Voice Activity Detection"*, IASTED International Conference on Signal Processing, Pattern Recognition, and Applications, pp. 298–303, 2007.
154. F. Pernkopf, *"Discriminative Learning of Bayesian Network Classifiers"*, IASTED International Confer-

ence on Artificial Intelligence and Applications, pp. 422–427, 2007.

155. M. Neffe, T.V. Pham, F. Pernkopf, H. Hering, and G. Kubin, *"Speaker Verification for Air Traffic Control"*, EUROCONTROL Innovative Research Workshop & Exhibition, 2006.
156. F. Pernkopf and T. V. Pham, *"Bayesian Networks for Phonetic Classification Using Time-Scale Features"*, International Conference on Spoken Language Processing (ICSLP), Interspeech, 2006.
157. F. Pernkopf, *"Discriminative Learning of Bayesian Network Classifiers"*, IASTED International Conference on Artificial Intelligence and Soft Computing, (oral), 2006.
158. F. Pernkopf and J. Bilmes, *"Discriminative versus Generative Parameter and Structure Learning of Bayesian Network Classifiers"*, International Conference on Machine Learning (ICML), pp. 657–664, 2005.
159. F. Pernkopf, *"On Initialization of Gaussian Mixtures: A Hybrid Genetic EM Algorithm"*, International Conference on Acoustics, Speech, and Signal Processing (ICASSP), pp. 693–696, 2005.
160. F. Pernkopf, *"3D Surface Inspection Using Coupled HMMs"*, International Conference on Pattern Recognition (ICPR), Vol. 03, No. 3, pp. 223–226, 2004.
161. F. Pernkopf, *"Bayesian Network Classifiers versus $k$-NN Classifiers Using Sequential Feature Selection"*, National Conference on Artificial Intelligence (AAAI), pp. 360–365, 2004.
162. V. Dizdarevic, M. Hagmüller, G. Kubin, F. Pernkopf, and M. Baum, *"Prosody-based Recognition of Spoken German Varieties"*, International Conference on Acoustics, Speech, and Signal Processing (ICASSP), vol. 1, pp. 929–932, 2004.
163. F. Pernkopf and P. O'Leary, *"A Search-and-Score Structure Learning Algorithm for Bayesian Network Classifiers"* SME Technical Paper MV03-329 (Society of Manufacturing Engineers, 2003), Reprint of QCAV 2003.
164. F. Pernkopf and P. O'Leary, *"A Search-and-Score Structure Learning Algorithm for Bayesian Network Classifiers"*, International Conference on Quality Control by Artificial Vision (QCAV), Proceedings of SPIE, Vol. 5132, pp. 231–240, 2003.
165. F. Pernkopf and P. O'Leary, *"Shape Description and Analysis of Range Data for Milled Steel Blocks"*, IS&T/SPIE Annual Symposium on Electronic Imaging, Proceedings of SPIE, Vol. 5011, pp. 74–81, 2003.
166. F. Pernkopf, F. Pernkopf and P. O'Leary, *"Detection of Surface Defects on Raw Milled Steel Blocks Using Range Imaging"*, IS&T/SPIE Symposium on Electronic Imaging, Proceedings of SPIE, Vol. 4664, pp. 170–181, 2002.
167. F. Pernkopf, P. O'Leary, *"Image Acquisition and Analysis Techniques for Automatic Visual Inspection of Metallic Surfaces"*, Verformungskundliches Kolloquium, pp. 180–187, 2002.
168. F. Pernkopf and P. O'Leary, *"Automatic Inspection System for Detection and Classification of Flaws on Turned Parts"*, International Conference on Quality Control by Artificial Vision (QCAV), pp. 359–364, 2001.
169. F. Pernkopf and P. O'Leary, *"Feature Selection for Classification Using Genetic Algorithms with a novel Encoding"*, International Conference on Computer Analysis of Images and Patterns (CAIP), pp. 161–168, LNCS Springer Verlag, 2001.
170. F. Pernkopf, A. Schiller, P. O'Leary, *"Quality Control of Metallic Surfaces by means of Digital Image Processing"*, Verformungskundliches Kolloquium, pp. 138–151, 2001.

## Theses

1. F. Pernkopf, *"Graphical Models: Discriminative Learning, Inference, and Applications"*, Habilitation Thesis, 202 pages, 2009.
2. F. Pernkopf, *"Automatic Visual Inspection of Metallic Surfaces"*, PhD Thesis, 145 pages, Fortschr.-Ber. VDI Reihe 8, Nr. 949, VDI-Verlag, 2002.
3. F. Pernkopf, *"Control Software for a 64 by 64 pixel Spatial Light Modulator"*, Master Thesis, 96 pages, University of Edinburgh / Graz University of Technology, 1999.

## Other Publications

1. F. Pernkopf, M. Wohlmayr, and G. Kubin, *"Pitch Tracking Corpus with Multipitch Tracking Evaluation"* IEEE Signal Processing Society Speech and Language Processing Technical Committee (SLTC) Newsletter, Winter 2012.
2. F. Pernkopf , F. Pernkopf, and P. O'Leary, *"Automatic Surface Inspection of Raw Milled Steel Blocks Using Range Imaging"*, Newsletter for SPIE's International Technical Group on Electronic Imaging, Vol. 12, No. 2, 2002.

## Patent

1. J. Rock, M. Toth, E. Messner, P. Meissner, F. Pernkopf *"FMCW Radar mit Störsignalunterdrückung mittels künstlichem neuronalen Netz"*, DE102019106529, 2019.
2. M. Wohlmayr, M. Stark, and F. Pernkopf *"Verfahren zur Ermittlung von Grundfrequenz-Verläufen mehrerer Signalquellen"*, AT 509512, 2012.