

Curriculum Vitae: Morten Mørup

CURRENT POSITION Assistant Professor, Section for Cognitive Systems, DTU Informatics

PERSONAL Born 12 January 1978

CONTACT INFORMATION

Home

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Work

Cognitive Systems, DTU Informatics
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RESEARCH INTERESTS

Machine Learning, Unsupervised Learning, Multi-way/Tensor Decomposition Methods, Bayesian Inference, Complex Networks, Neuroimaging, Bioinformatics.

EDUCATION AND RESEARCH EXPERIENCE

Copenhagen University,

Bio-physics and Mathematics: (Fall 1999 - Summer 2001)

Washington State University,

Exchange student following courses within Computational Neuroscience (Spring 2004)

Technical University of Denmark

Cand. Polyt. Applied Mathematics (February 2005)

PhD Intelligent Signal Processing Group at DTU Informatics (September 2008)
Dissertation title: Decomposition Methods for Unsupervised Learning.

PostDoc Intelligent Signal Processing Group at DTU Informatics (2008-2009)
Project: PERCEPT: Perceptual Consciousness Explication and Testing
(<http://www.nest-percept.eu/>)

Assistant Professor, Section for Cognitive Systems, DTU Informatics (Current Position)

Stanford University

Visiting Ph.D. Student at Department for Scientific Computing (Summer 2006 - Fall 2006)
Host: Professor Gene H. Golub

Berkeley University

Visiting Ph.D. Student at Department of Mathematics (Fall 2007)
Host: Morrey Assistant Professor Lek-Heng Lim

HONORS AND AWARDS

Best Thesis Award: Direktør Peter Gorm-Petersens Mindelegat 2008 (14.000 DKR)

Elite Research Travel Scholarship 2007: Danish Ministry of Science (250.000 DKR)

Travel Award: Organization for Human Brain Mapping 2005

TEACHING
EXPERIENCE

Technical University of Denmark

Teacher 02450: Introduction to Machine Learning and Data Modelling (2010-2012)
Teacher 02582: Computational Data Analysis (2010-2012)
Teacher 02901: Advanced Digital Signal Processing (Summer 2008, 2010,2011,2012)
Assistant Teacher 02405: Probability Theory (2005-2007)
Assistant Teacher 02409: Multivariate Statistics (2004-2005)
Assistant Teacher 02701: Introduction to Operations Research (2002-2003)

Have further given lectures or been assistant teacher in the following courses:

02451 Digital Signal Processing, 02457 Non-linear signal processing , 02459 Machine Learning for Signal Processing and co-supervised several masters and bachelor students. And taught at the "1st International Summer School in Biomedical Engineering", Erfurt, Germany 2006 as well as the "Advances in MRI of human brain structure and function" at Hvidovre Hospital, 2009.

MEETINGS
ORGANIZED

2009 European Workshop on Challenges in Modern Massive Data Sets Organizer (with L.-H. Lim, M. Mahoney, L.K. Hansen, G. Carlsson), Technical University of Denmark, Lyngby, Denmark, July 1-4, 2009. (<http://mmds.imm.dtu.dk>)

PROFESSIONAL
ACTIVITIES

Member of the Machine Learning for Signal Processing Technical Committee of the IEEE Signal Processing Society. Reviewer for the Netherlands Organisation for Scientific Research (NWO). Editorial Board Member of the World Journal of Methodology. National Representative FuturICT.

KEY PUBLICATIONS

F. Calamante , M. Mørup, L. K. Hansen, Defining a local arterial input function for perfusion MRI using independent component analysis. *Magnetic Resonance in Medicine*, Volume 52 Issue 4, Pages 789 - 797, 2004

This paper proposes the use of Independent Component Analysis to extract arterial input functions for perfusion MRI data. A software assisting medical doctors in the analysis was developed.

Citations: Google Scholar 73, ISI 44

M. Mørup, L. K. Hansen, C. S. Hermann, J. Parnas, S. M. Arnfred, Parallel Factor Analysis as an exploratory tool for wavelet transformed event-related EEG. *NeuroImage*, vol. 29(3), pp. 938-947, 2006

This paper proposes the use of multi-linear approaches for the analysis of wavelet transformed event related EEG data and demonstrate its success in correctly extracting the underlying neurological activation of a visual paradigm.

Citations: Google Scholar 81, ISI 32

M. Mørup, L.K. Hansen, S.M. Arnfred, ERPWAVELAB A toolbox for multi-channel analysis of time-frequency transformed event related potentials. *Journal of Neuroscience Methods*, vol. 161, pp. 361-368, 2007

This paper presents the open source toolbox ERPWAVELAB for time-frequency analysis of event related EEG and MEG data.

Citations: Google Scholar 35 , ISI 6

M. Mørup, L.K. Hansen, S.M. Arnfred, L.-H. Lim, K.M. Madsen, Shift Invariant Multilinear Decomposition of Neuroimaging Data. *NeuroImage* vol. 42(4), pp.1439-50, 2008

This paper proposes a framework to model the inevitable delay variability in neuroscience data. On fMRI and EEG data it is demonstrated how the proposed approach effectively extracts the underlying neural activity despite SNR's less than -10dB. The algorithm is publicly available.

Citations: Google Scholar 7 , ISI

M. Mørup, L. K. Hansen, S. M. Arnfred, Algorithms for Sparse Nonnegative Tucker Decomposition. *Neural Computation*, vol. 20 no. 8, pp. 2112-2131, 2008

We demonstrate how tensor decomposition based on the Tucker model incorporating sparseness

can be used to turn of excess components and alleviate model ambiguities. Results on a range of life-science data from chemometrics and neuroscience demonstrate the success of the approach. The algorithm is publicly available.
Citations: Google Scholar 25 , ISI

FULL LIST OF
PUBLICATION

16 Journal and 26 conference or workshop papers accumulated.

Total of 557 Google Scholar and 207 ISI citations as of November 2011.

Journal Publications

M. Mørup, M. N. Schmidt, Bayesian Community Detection, accepted for publication Neural Computation, 2012.

M. Mørup, L. K. Hansen, Archetypal Analysis for Machine Learning and Data Mining, Neuro-Computing, Vol. 80(5463), 2011.

M. Mørup, Applications of tensor (multi-way array) factorizations and decompositions in data mining, Wiley DMKD 2011.

C. Stahlhut, M. Mørup, O. Winther, L. K. Hansen, Simultaneous EEG Source and Forward Model Reconstruction (SOFOMORE) using a Hierarchical Bayesian Approach, Journal of Signal Processing Systems, 2010. 3mm

E. Acar, D. M. Dunlavy, T. G. Kolda, M. Mørup, Scalable tensor factorizations for incomplete data, Chemometrics and Intelligent Laboratory Systems 2010.

S. M. Arnfred, M. Mørup, J. Thalbitzera, L. Janssona, J. Parnas, Attenuation of beta and gamma oscillations in schizophrenia spectrum patients following hand posture perturbation, Psychiatric Research, vol. 185(1-2), pp. 215-224, 2010.

I. Griskova, M. Mørup, Josef Parnas, Osvaldas Ruksenas, Sidse M. Arnfred, Two discrete components of the 20 Hz steady-state response are distinguished through the modulation of activation level. Clinical Neurophysiology, vol. 120, pp. 904-909, 2009

M. Mørup, L.K. Hansen, Automatic Relevance Determination for multi-way models, Journal of Chemometrics, vol. 23(7-8), pp. 352-363, 2009

M. Mørup, L.K. Hansen, S.M. Arnfred, L.-H. Lim, K.M. Madsen, Shift Invariant Multilinear Decomposition of Neuroimaging Data. NeuroImage vol. 42(4), pp.1439-50, 2008

M. Mørup, L. K. Hansen, S. M. Arnfred, Algorithms for Sparse Nonnegative Tucker Decomposition. Neural Computation, vol. 20 no. 8, pp. 2112-2131, 2008

I. Griskova, M. Mørup, J. Parnas, O. Ruksenas, O., S.M. Arnfred, The amplitude and phase precision of 40 Hz auditory steady-state response depend on the level of arousal. Experimental Brain Research, vol. 183(1), pp. 133-138, 2007

M. Mørup, L.K. Hansen, S.M. Arnfred, ERPWAVELAB A toolbox for multi-channel analysis of time-frequency transformed event related potentials. Journal of Neuroscience Methods, vol. 161, pp. 361-368, 2007

S.M. Arnfred, L.K. Hansen, L. K., J. Parnas, M. Mørup, Proprioceptive Evoked Gamma Oscillations. Brain Research, vol. 1147, pp. 167-174, 2007

M. Mørup, L. K. Hansen, C. S. Hermann, J. Parnas, S. M. Arnfred, Parallel Factor Analysis as an exploratory tool for wavelet transformed event-related EEG. NeuroImage, vol. 29(3), pp. 938-947, 2006

F. Calamante , M. Mørup, L. K. Hansen, Defining a local arterial input function for perfusion MRI using independent component analysis. Magnetic Resonance in Medicine, Volume 52 Issue

Conference Proceedings

R. Tomioka, M. Mørup, A Bayesian Analysis of the Radioactive Releases of Fukushima, AISTATS 2012.

M. Mørup, M.N. Schmidt, Transformation Invariant Sparse Coding, Accepted for publication, Machine Learning for Signal Processing (MLSP), 2011 IEEE Workshop on

T.J. Hansen, M. Mørup, L.K. Hansen, Non-Parametric Co-Clustering Of Large Scale Sparse Bipartite Networks On The GPU, Machine Learning for Signal Processing (MLSP), 2011 IEEE Workshop on

M. Mørup, K. H. Madsen, L. K. Hansen, Modeling Latency and Shape Changes in Trial Based Neuroimaging Data, Accepted for publication, ASILOMAR, 2011

M. Mørup, K. H. Madsen, L. K. Hansen, Frequency Constrained ShifCP Modeling of Neuroimaging Data, Accepted for publication ASILOMAR, 2011

M. Mørup, K. H. Madsen, A. M. Dogonowski, H. Siebner, L. K. Hansen, Infinite Relational Modeling of Functional Connectivity in Resting State fMRI, Neural Information Processing Systems 23, pp. 1750-1758, 2010

T. J. Hansen, M. Mørup, L.K. Hansen, Large Scale GPU Based Inference for the Infinite Relational Model. NIPS workshop on Low-rank Methods for Large-scale Machine Learning, 2010.

M. Mørup, M. N. Schmidt, L. K. Hansen, Infinite Multiple Membership Relational Modeling for Complex Networks, first presented at NIPS Workshop on Networks Across Disciplines in Theory and Application, 2010. Accepted for publication, Machine Learning for Signal Processing (MLSP), 2011 IEEE Workshop on

M. N. Schmidt, M. Mørup, Infinite non-negative matrix factorization, European Signal Processing Conference (EUSIPCO), pp. 905-909, 2010

M. Mørup, L. K. Hansen, Archetypal Analysis for Machine Learning, Machine Learning for Signal Processing (MLSP), IEEE Workshop on, 2010

M. K. Petersen, M. Mørup, L. K. Hansen, Latent Semantics As Cognitive Components, 2nd International Workshop On Cognitive Information Processing, 2010

E. Acar, D. Dunlavy, T. G. Kolda, M. Mørup, Scalable Tensor Factorizations with Missing Data, Proceedings of the 2010 SIAM International Conference on Data Mining

M. K. Petersen, M. Mrup, L. K. Hansen, Sparse but emotional decomposition of lyrics, 3rd International Workshop on Learning Semantics of Audio Signals (LSAS), 2009

C. Stahlhut, M. Mørup, O. Winther, L. K. Hansen, Hierarchical Bayesian Model for simultaneous EEG Source and Forward Model Reconstruction (SOFOMORE). Accepted for publication Machine Learning for Signal Processing, 2009 IEEE Workshop on

C. Stahlhut, M. Mørup, O. Winther, L. K. Hansen : Sofomore: Combined EEG Source and Forward Model Reconstruction , IEEE International Symposium on Biomedical Imaging , 2009

M. Mørup, L.K.Hansen, Tuning Pruning in Sparse Non-negative Matrix Factorization. Accepted, European Signal Processing Conference (EUSIPCO-2009)

C. Stahlhut, M. Mørup, O. Winther, L. K. Hansen, SOFOMORE: Combined EEG Source and Forward Model Reconstruction. Accepted for publication 2009 IEEE International Symposium

on Biomedical Imaging

V. Potluru, S. Plis, M. Mørup, V. Calhoun, T. Lane, Efficient Multiplicative updates for Support Vector Machines. SIAM International Conference on Data Mining (SDM09)

M. Mørup, L.K. Hansen, Sparse Coding and Automatic Relevance Determination for Multi-way models. Signal Processing with Adaptive Sparse Structured Representations (Spars09)

M. Mørup, K.H. Madsen, L.K. Hansen, Approximate L0 constrained Non-negative Matrix and Tensor Factorization. IEEE International Symposium on Circuits and Systems (ISCAS), special session on Non-negative Matrix and Tensor Factorization and Related Problems, pp. 1328 - 1331, 2008

P. M. Rasmussen, M. Mørup, L. K. Hansen, S. M. Arnfred, Model Order Estimation for Independent Component Analysis of Epoched EEG Signals. Biosignals 2008, International Conference on Bio-inspired Systems and Signal Processing, 2008

M. Mørup, L. H. Clemmensen, Multiplicative updates for the LASSO. Machine Learning for Signal Processing, 2007 IEEE Workshop on, pp. 33-38, 2007

M. Mørup, K. H. Madsen, L. K. Hansen, Shifted Non-negative Matrix Factorization. Machine Learning for Signal Processing, 2007 IEEE Workshop on, pp. 139-144, 2007

M. Mørup, K. H. Madsen, L. K. Hansen, Shifted Independent Component Analysis. Independent Component Analysis and Signal Separation, Lecture Notes in Computer Science 4666, pp. 89-96, 2007

M. N. Schmidt, M. Mørup, Nonnegative Matrix Factor 2-D Deconvolution for Blind Single Channel Source Separation. Independent Component Analysis and Blind Signal Separation 3889 pp. 700-707, 2006

Editorials

A. Cichocki, M. Mørup, P. Smaragdis, W. Wang, and R. Zdunek, Editorial. Advances in Non-negative Matrix and Tensor Factorization, Computational Intelligence and Neuroscience, 2008

Technical Reports

M. Mørup, K. H. Madsen, L. K. Hansen, Latent Causal Modelling of Neuroimaging Data, NIPS Workshop on Connectivity Inference in Neuroimaging 2009

M. Mørup, L. K. Hansen, Learning Latent Structure in Complex Networks, Workshop on Analyzing Networks and Learning with Graphs NIPS 2009

M. Mørup, M. N. Schmidt, L. K. Hansen, Shift Invariant Sparse Coding of Image and Music Data. Technical report no: IMM2008-04659, 2008

M. Mørup, L. K. Hansen, J. Parnas, S. M. Arnfred, Decomposing the time-frequency representation of EEG using non-negative matrix and multi-way factorization. Technical report no: IMM2006-04144, 2006

M. N. Schmidt, M. Mørup, Sparse Non-negative Matrix Factor 2-D Deconvolution for Automatic Transcription of Polyphonic Music. Technical report no: IMM2006-04100, 2006

Selected Software

www.erpwavelab.org: Open source toolbox for analysis and visualization of wavelet transformed event related electroencephalograph (EEG) and magneto-encephalography (MEG) data. (As of 23rd September 2008 downloaded by more than 200 different institutions).

ARDTUCKER and ARD-SC: Algorithms to perform model order estimation for the Tucker and

CP model based on Automatic Relevance Determination including sparse coding as a special case.

ShiftCP: Algorithm to estimate the CandComp/PARAFAC model with delay variability across one mode.

sr-clustering: Software based on simplicial relaxation to clustering that recover the assignment problem upon convergence. Can solve k-means, pairwise clustering and community detection in networks based on Modularity and Hamiltonian optimization.

SELECTED INVITED TALKS Psychology and Brain 2011 symposium on Applying Trilinear Component Analysis to ERP and fMRI data, Heidelberg, Germany, June 2011

Inaugurational Symposium of the Contact project granted by the Lundbeck Foundation, Charlottenlund, May 2011

NIPS workshop on Tensors Kernels and Machine Learning, Canada 2010.

Bayesian methods for tensor decomposition, BIT50 - Trends in Numerical Computing, Lund, Sweden, June 2010,

Unsupervised Multi-way decomposition, PhD course: Advances in MRI of human brain structure and function, Danish Research Centre for Magnetic Resonance, Hvidovre Hospital, October 2009

Bayesian and Non-linear Multi-way analysis, Three-way methods In Chemistry And Psychology, TRICAP 2009, Nuria, Spain, 2009

The wonders of the L1-norm, Seminar at Informatics and Mathematical Modelling, Seminar at DTU Informatics, April 2008

Decomposing data under invariance constraints, Image Analysis, Computer Graphics and Geoinformatics 9th Annual Workshop, DTU, December 2007

Shift Invariant Data Decomposition, Seminar at Lawrence Livermore Lab, Berkeley, USA, November 2007

Sparseness constraints and non-negative tensor factorization, Session on: Tensor decompositions and their application ICIAM, ETH Zürich, Switzerland, July 2007

Non-negative tensor decomposition, seminar at Scientific Computing, Stanford, USA, October 2006 and Sandia National Lab, Livermore, USA August 2006

An introduction to ERPWAVELAB, Columbia University, October 2006

Extensions of non-negative matrix factorization to higher order data, Three-way methods In Chemistry And Psychology, TRICAP 2006, Crete, Greece, June 2006

REVIEWING EXPERIENCE

Statistics in Medicine, ISCAS 2007, Computational Intelligence and Neuroscience, EURASIP JASP, IEEE Transactions on Biomedical Engineering, Journal of Neuroscience Methods, EUSIPCO 2008, Computer Physics Communication, Signal Processing, Journal of Chemometrics, EUSIPCO 2009, Neural Processing Letters, Data Mining and Knowledge Discovery, EUSIPCO 2010, Machine Learning for Signal Processing (MLSP2010), Latent Variable Analysis and Signal Separation (LVA/ICA2010), NeuroImage, The Journal of Neuroscience, Human Brain Mapping (Wiley), Transactions on Pattern Analysis and Machine Intelligence (TPAMI), Neural Computation, International Conference

on Acoustics, Speech and Signal Processing (ICASSP2011), Linear Algebra and its Applications, ICANN 2011, MICCAI2011, EUSIPCO2011, NeuroComputing, MLSP 2011, IEEE Transactions on Signal Processing, ICONIP 2011, Cognitive Information Processing (CIP2012), SIMAX.