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Mathematician
Space Farmer
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EDUCATION



[University of Michigan](#) Jan. 1992 - May 1996
Ph.D., Mathematics, **Negative Eigenvalues of the Schrödinger Equation: an Approach through Fractional Integration and Morrey Spaces**, GPA 8.13 (9=A+, 8=A, ...).



Norwegian University of
Science and Technology

[Norwegian Institute of Technology](#) Aug. 1986 - Dec. 1990
Sivilingeniør, (M.S., Engineering), Mathematics, GPA 1.5 (1.0=A+, 1.5=A, ...).

EMPLOYMENT



[Research For Industries, Microsoft Research](#) January 2020 - present
[Azure Global Research, Microsoft](#) June 2019 - December 2020
Principal Research Scientist



[IBM, Thomas J. Watson Research Center](#) March 2016 - May 2019
Principal Research Staff Member and Area Head of Machine Learning and Analytics Algorithms.

[IBM, Thomas J. Watson Research Center](#) August 2015 - February 2016
Area Head Machine Learning and Analytics Algorithms.

[IBM, Thomas J. Watson Research Center](#) April 2014 - July 2015
Manager Analytics Algorithms group.

[IBM, Thomas J. Watson Research Center](#) April 2012 - March 2014
Research Staff Member in the Business Analytics and Mathematics Department. Primary work on prescription fraud analytics, farming analytics from satellite imagery, convex and non-smooth optimization.

[IBM, Thomas J. Watson Research Center](#) May 2010 - March 2012
Research Staff Member in the Human Language Technology Group. Primary lead on acoustic modeling track for Nuance JDA.

[IBM, Thomas J. Watson Research Center](#) 2007 - May 2010
Manager Speech Recognition Algorithms and Engines group. Responsible for speech recognition algorithms for IBM's embedded Via Voice and web-sphere voice server products. Directed technology transfers to 8 of IBM's research and development labs worldwide.

[IBM, Thomas J. Watson Research Center](#) Jan. 1998 - 2006
Research Staff Member in the Human Language Technology Group. Research and development in speech recognition.

[IBM, Thomas J. Watson Research Center](#) May 1996 - Dec. 1997
Postdoctoral position in the Human Language Technology Group.



University of Michigan Aug. - Dec. 1995
Teaching Assistant in first term calculus class, Mathematics 115, section 6. Taught, graded homework and exams and assigned final grades.



Norwegian Defense Research Establishment Mar. - Dec. 1991
Norwegian military service. Computational and mathematical modeling of naval attack scenarios.

AWARDS

1. *Research Division Award – Multi-talker ASR*, Issued by John Kelly III, Senior Vice President, Research, IBM, October 2010.
2. *IEEE Senior Member*, February 2010 - present.
3. *Watson Chair of the User Interface Technology (UIT) Professional Interest Community (PIC)*, IBM, November 2008 - February 2011.
4. *Outstanding Teamwork and Extraordinary Effort toward Closing a Significant Speech Deal for IBM*, Issued by Charles Lickel, Vice President, Software, IBM, March 2009. For help with closing a speech contract with Nuance.
5. *Research Division Award – Contributions to Embedded ViaVoice Speech Recognition Engine*, Issued by Paul M. Horn, Senior Vice President, Research, IBM, January 2005. For dramatic reductions in word error rate and for generating product level acoustic models for US English for embedded ViaVoice product line.
6. *Outstanding Technical Achievement Award in Appreciation for: Technical Contributions to Embedded Via Voice*, Issued by Chairman and Chief Executive Officer Samuel Palmisano, IBM, July 2003. For deployment of speech recognition engine in the 2003 and 2004 Honda Accord models.
7. *A Second Plateau – Invention Achievement Award in appreciation and recognition of creative contributions to IBM progress*, issued by Louis V. Gerstner Chairman and Chief Executive Officer, IBM, June 2001.
8. *Supplemental Patent Issue Award*, IBM, June 2000.
9. *Outstanding Technical Achievement Award in Appreciation for: Broadcast News Transcription Technologies*, issued by Louis V. Gerstner Chairman and Chief Executive Officer, IBM, July 1999.
10. *A First Plateau – Invention Achievement Award in appreciation and recognition of creative contributions to IBM progress*, issued by Louis V. Gerstner Chairman and Chief Executive Officer, IBM, December 1998.
11. *A First Patent Application Invention Award for Method and Apparatus for Error Correction in a Continuous Dictation System*, issued by Louis V. Gerstner Chairman and Chief Executive Officer, IBM, February 1997.
12. *Doctoral fellowship*, NFR–Norges Forskningsråd (The Norwegian Research Council), 1992–1995.
13. *Chemistry and Mathematics Award*, “Dragseth’s fond”, Tønsberg Gymnas (high school), Tønsberg, Norway, June 1986.
14. 8th place, The Niels Henrik Abel Competition, Oslo, Norway, April 1986.

PROGRAMMING LANGUAGES

Currently I'm working with Python (AI+Geospatial) and GMTSAR5 (SAR+InSAR).

- Python, C++, C, Perl, Perl5, Matlab, Mathematica, D, Julia
- Python: Numpy, matplotlib, cython, scipy, scikit-learn, scikit-image, opencv, pandas, pytorch, tensorflow, tkinter, PyQt, PySide6, osgeo, ogr, gdal, rasterio, folium, ipyleaflet, leafmap.
- GMTSAR5.

VOLUNTEERING

ICML	Local Chair ICML 2016 Won bid to host the 33rd International Conference on Machine Learning in New York City.	2016
MLSP	Technical committee member MLSP-SPS Elected as member of the <i>Machine Learning for Signal Processing</i> of the IEEE Signal Processing Society (SPS).	2015-2017
SLTC	Technical committee member SLTC-SPS Re-elected member of the <i>Speech and Language Processing Technical Committee</i> serving on the Awards subcommittee of the IEEE Signal Processing Society (SPS)	2015-2016
SLTC	Technical committee member SLTC-SPS Elected member of the <i>Speech and Language Processing Technical Committee</i> of the IEEE Signal Processing Society (SPS)	2013-2014
Hackathon Microsoft	Ocean plastic labeling, Apple counting.	Won first and third prize.
Reviewer	ICASSP (1997-2015), Eurospeech, Interspeech, ASRU, MLSP, NIPS, KDD, ICML, AAAI, Transactions in Speech and Audio Processing, Computer Speech and Language, IEEE Signal Processing Letters.	

PROJECTS

This is a selection of projects I have worked on. If you are viewing this in a browser or a basic PDF reader (use [Adobe](#)) you will not be able to see animations or listen to audio samples. You can also view these projects (and others) on my [project home page](#).

PROJECT SPACEYE

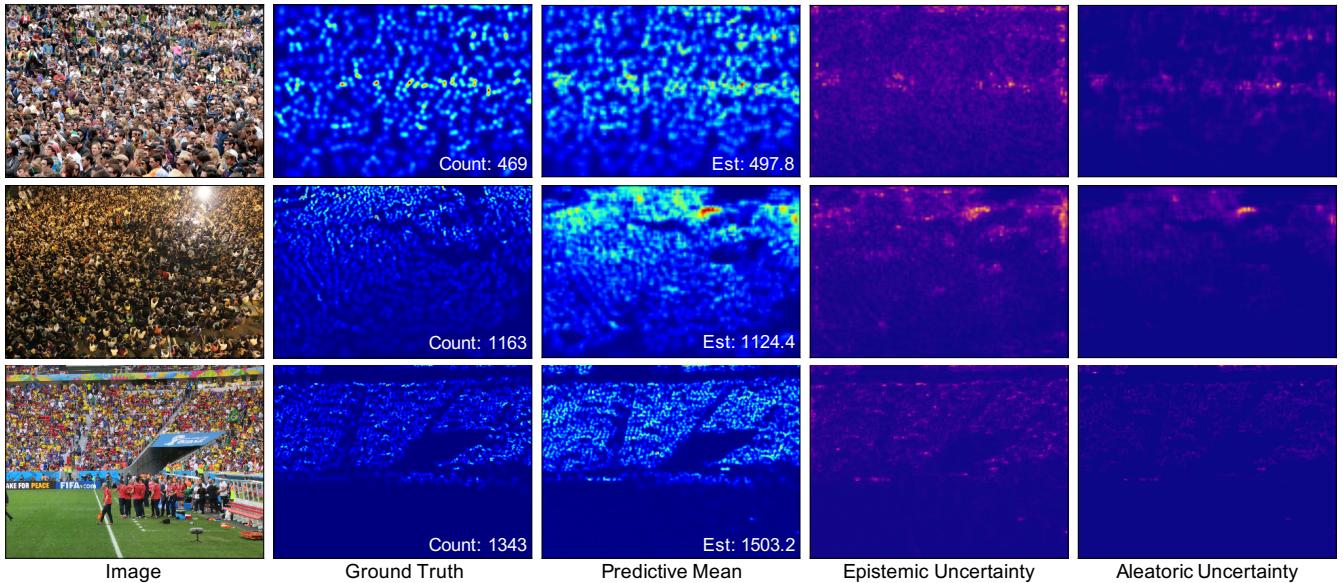
Project SpaceEye is a cloud removal system for satellite images that uses synthetic aperture radar to "see through clouds". The system is available as an API through [FarmVibes](#). The idea was to use neural attention to interpolate cloud-free patches to replace cloudy optical patches. This closely resembles approaches that have used temporal interpolation to fill in missing data, but here we use radar data to guide the interpolation. The system was trained on [Sentinel-1](#) and [Sentinel-2](#) data from the European Space Agency (via [Microsoft Planetary Computer](#)).

LOCATION AWARE SUPER RESOLUTION

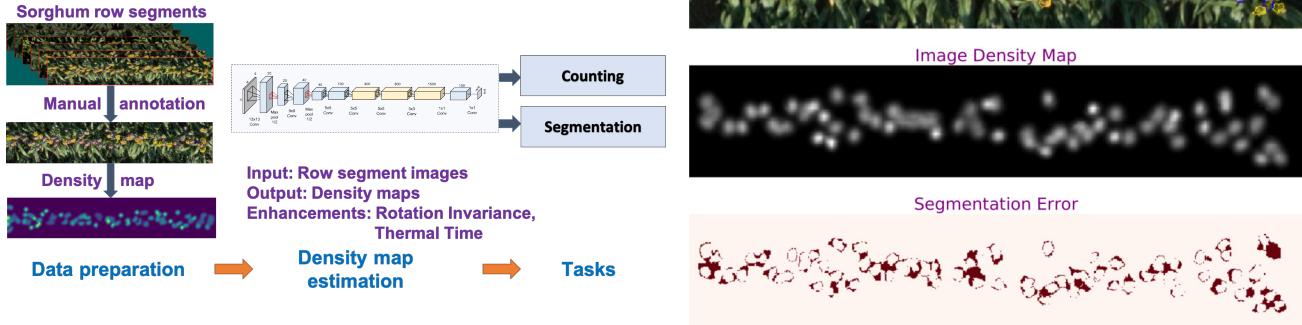
Precision farming using satellite imagery is hampered by the presence of clouds and by the low spatial resolution from freely available data sources. In this project we used super-resolution with historical high-resolution imagery to create high-quality super-resolved images. We called the project LASR (Location-Aware Super Resolution). The video on the right demonstrates the performance of the system for six locations in Washington State. The first row shows the input data from Sentinel-2 and Pléiades as well as our location sharpening method. The second row shows traditional super-resolution methods while the third row shows LASR methods from our [IGARSS 2922 paper](#).

OBJECT COUNTING

The competitive task for object counting is crowd counting. We built a system to estimate the crowd density as well as the prediction error.



Here we count *sorghum panicles*. Furthermore, we derive an *instance segmentation* from the image density map and use *isotonic regression* to force the counts to increase as a function of time. (Zoom in to clearly see the annotated panicle borders.) A demonstration of the annotation tool I wrote to annotate data is available [here](#).



SPEECH SEPARATION

Single microphone simultaneous recognition and audio separation. (click to listen)



PUBLICATIONS

The total number of citations for my articles is greater than 5300 as calculated by Google Scholar (the most recent number can be found [here](#)). My Google H-index is 33 and the Erdős number is 3. The Olsen inequality is named after my thesis work.

JOURNAL ARTICLES

- [1] Arif Masrur, Peder Olsen, Paul Adler, Carlan Jackson, Matthew Myers, Nathan Sedghi and Ray R Weil, [Learning to see more: UAS-guided super-resolution of satellite imagery for precision agriculture](#). *arXiv preprint, arXiv:2505.21746*, 2025.
- [2] Mingmin Zhao, Peder A. Olsen and Ranveer Chandra, [Seeing through clouds in satellite images](#). *IEEE Transactions on Geoscience and Remote Sensing*, **61** p. 1-16, 2023.

- [3] Sholom M Weiss, Casimir A Kulikowski, Robert S Galen, Peder A Olsen and Ramesh Natarajan Managing healthcare costs by peer-group modeling, *Applied Intelligence*, **43**(4), p. 752-759, December 2015.
- [4] Gillian Chin, Jorge Nocedal, Peder A. Olsen and Steven J. Rennie. "Second order methods for optimizing convex matrix functions," *IEEE Transactions on Audio, Speech, and Language Processing, Special Issue on Optimization*, **21**(11), p. 2244-2254, November 2013.
- [5] Xiaodong Cui, Jian Xue, Xin Chen, Peder A. Olsen, Pierre L. Dognin, Upendra V. Chaudhari, John R. Hershey and Bowen Zhou. "Hidden Markov acoustic modeling with bootstrap and restructuring for low resourced languages," *IEEE Transactions on Audio, Speech, and Language Processing*, **20**(8), p. 2252-2264, October 2012.
- [6] Steven J. Rennie, John R. Hershey and Peder A. Olsen. [Single-channel multitalker speech recognition](#). *Signal Processing Magazine*, **27**, p. 66-80, November 2010. Special issue: Graphical Modeling.
- [7] John R. Hershey, Steven Rennie, Peder A. Olsen and Trausti Kristjansson. Factorial dynamics for single channel speech separation and recognition. *Computer, Speech and Language*, **24**, p. 45-66, January 2010. Special issue: Speech Separation and Recognition.
- [8] Scott Axelrod, Vaibhava Goel, Ramesh A. Gopinath, Peder A. Olsen and Karthik Visweswarah. Discriminative estimation of subspace constrained gaussian mixture models for speech recognition. *Transactions in Speech and Audio Processing*, **15** (1): 172-189, January 2007.
- [9] Scott Axelrod, Vaibhava Goel, Ramesh A. Gopinath, Peder A. Olsen and Karthik Visweswarah. Subspace constrained gaussian mixture models for speech recognition. *Transactions in Speech and Audio Processing*, **13** (6): 1144-1160, November 2005.
- [10] Peder Olsen and Ramesh Gopinath. [Modeling inverse covariance matrices by basis expansion](#). *Transactions in Speech and Audio Processing*, **12** (1):37-46, January 2004.
- [11] Sabine Deligne, Satya Dharamipragada, Ramesh Gopinath, Peder Olsen, and Harry Printz. A robust high accuracy speech recognition system for mobile applications. *Transactions in Speech and Audio Processing*, **10** (8): 551-561, November 2002. Special issue on automatic speech recognition for mobile and portable devices.
- [12] Sankar Basu, Mohammad Saif Ullah Khan, Charles A. Micchelli and Peder A. Olsen. On an optimization problem arising from probability density estimation. *Revista de la Real Academia de Ciencias, Serie A. Matemáticas*, **96** (2): 139-156, 2002.
- [13] Harry Printz and Peder Olsen. Theory and practice of acoustic confusability. *Computer, Speech and Language*, **16** (1): 131-164, January 2002. Special issue: Advances in large vocabulary speech recognition.
- [14] Scott S. Chen, Ellen M. Eide, Mark J. F. Gales, Ramesh A. Gopinath, Dimitri Kanevsky, and Peder Olsen. Automatic transcription of broadcast news. *Speech Communications*, **37** (1-2):69-87, May 2001.
- [15] Charles Micchelli and Peder Olsen. [**Penalized maximum likelihood estimation, the Baum Welch algorithm, diagonal balancing of symmetric matrices and applications to training acoustic data.**](#) *Journal of Computational and Applied Mathematics*, **119**(1-2):310-331, 2000. Special issue in dedication to Professor Larry Schumaker on the occasion of his 60th birthday.
- [16] Sankar Basu, Charles Micchelli, and Peder Olsen. Power exponential densities for the training and classification of acoustic vectors in speech recognition. *Journal of Computational and Graphical Statistics*, **10**(1):158-192, March 2001.
- [17] Joseph Conlon and Peder Olsen. Fluctuations of Brownian motion with drift. *Publicacions Matematiques*, **43**:85-125, 1999.
- [18] Joseph Conlon and Peder Olsen. Estimates on the solution of an elliptic equation related to Brownian motion with drift, ii. *Revista Matemática Iberoamericana*, **13** (3):567-711, 1997.
- [19] Joseph Conlon and Peder Olsen. A Brownian motion version of the directed polymer problem. *Journal of Statistical Physics*, **84** (3/4):415-454, August 1996.

- [20] Peder Olsen and Renming Song. Diffusion of directed polymers in a strong random environment. *Journal of Statistical Physics*, **83** (1/2):727–738, May 1996.
- [21] Peder Olsen. Fractional integration, Morrey spaces and a Schrödinger equation. *Communications in Partial Differential Equations*, **20**(11/12):2004–2057, 1995.
- [22] Kristian Seip and Peder A. Olsen. A note on irregular discrete wavelet transforms. *IEEE Transactions on Information Theory*, **38**(2):861–864, March 1992.

CONFERENCE PROCEEDINGS

- [23] Kuntai Du, Yihua Chen, Peder Olsen, Shadi Noghabi and Jungchen Jiang, [Earth+: On-board satellite imagery compression leveraging historical earth observations](#). *ASPLoS 2025*, **30**, p. 361–276, March 2025.
- [24] Angela Busheska, Vikram Iyer, Bruno Silva, Peder Olsen, Ranveer Chandra and Vaishnavi Ranganathan, [TerraTrace: Spatio-temporal vegetation signatures for land use analytics](#). *International Workshop on Mobile Computing Systems and Applications*, **26**, p. 123-123, 2025.
- [25] Ishita Bansal Peder Olsen, and Roberto Estevão. [Remote sensing for weed detection and control](#). *arXiv preprint*, [arXiv:2410.22554](#), 2024.
- [26] Margaret Capetz, Swati Sharma, Rafael Padilha, Peder Olsen, Jessica Wolk, Emre Kiciman and Ranveer Chandra, [Enabling adoption of regenerative agriculture through soil carbon copilots](#). *arXiv preprint*, [arXiv:2411.16872](#), November 2024.
- [27] Kiran Mantripragada, Paul R. Adler, Peder A. Olsen, Faisal Z. Qureshi, [An iterative method for hyperspectral pixel unmixing leveraging latent Dirichlet variational autoencoder](#). *IGARSS 2023*, p. 7527–7530, 2023.
- [28] Olaoluwa Adigun, Peder A Olsen and Ranveer Chandra, [Location aware super-resolution for satellite data fusion](#). *IGARSS 2022*, July 2022.
- [29] Daniel D Morris, Robert Z Shrote, Ruijuan Tan, Linsey Newton, Robert F Goodwin, Erin L Bunting, Alexander E Lipka, Peder A Olsen and Addie Thompson, [Modeling canopy architecture traits using UAS-acquired LiDAR features in diverse maize varieties](#), *NAPPN 2022*, February 2022.
- [30] Mingmin Zhao, Peder A. Olsen and Ranveer Chandra, [Seeing Through Clouds in Satellite Images](#), *arXiv preprint* [arXiv:2106.08408](#), June 2021.
- [31] Min-hwan Oh, Peder Olsen and Karthikeyan Natesan Ramamurthy, [Crowd counting with decomposed uncertainty](#). *AAAI 2020*, **34**, p. 11799–11806, 2020.
- [32] Min-hwan Oh, Peder Olsen, Karthikeyan Natesan Ramamurthy, [Counting and segmenting sorghum heads](#). *arXiv preprint*, [arXiv:1905.13291](#), 2019.
- [33] Amit Dhurandhar, Karthikeyan Shanmugam, Ronny Luss and Peder A. Olsen, [Improving simple models with confidence profiles](#) *NeurIPS 2018*, Montreal, Canada, December 2018.
- [34] Peder Olsen, Karthikeyan Natesan Ramamurthy, Javier Ribera, Yuhan Chen, Addie Thompson, Ronny Luss, Mitch Tuinstra and Naoki Abe, [Detecting and counting panicles in Sorghum images](#) *DSAA 2018*, Turin, Italy, October 2018.
- [35] Jialei Wang, Peder Olsen, Andrew R Conn, Aurélie C Lozano, [Removing clouds and recovering ground observations in satellite image sequences via temporally contiguous robust matrix completion](#). *CVPR 2016*, p. 2754–2763, 2016. *SIAM Data Mining Conference 2014*, Philadelphia, PA, April 2014.
- [36] Aleksandr Aravkin, Stephen Becker, Volkan Cevher and Peder Olsen, [A variational approach to stable principal component pursuit](#). *UAI 2014*, Quebec, Canada, July 2014.

- [37] Peder A. Olsen, Ramesh Natarajan and Sholom M. Weiss [Graphical models for identifying fraud and waste in healthcare claims](#). *SIAM Data Mining Conference 2014*, Philadelphia, PA, April 2014.
- [38] Cho-Jui Hsieh and Peder Olsen Nuclear Norm Minimization via Active Subspace Selection. *ICML 2014*, Beijing, China, June 2014.
- [39] Jing Huang, Peder A Olsen, Vaibhava Goel State of the art discriminative training of subspace constrained Gaussian mixture models in big training corpora. *ICASSP 2013*, Vancouver, Canada, May, 2013.
- [40] Gillian Chin, Jorge Nocedal, Peder Olsen and Steven J. Rennie Optimizing convex matrix functions. *NIPS 2012*, Log-Linear Workshop, Lake Tahoe, Nevada, December 8, 2012.
- [41] Peder A. Olsen, Figen Oztoprak, Jorge Nocedal and Steven J. Rennie [Newton-like methods for sparse inverse covariance estimation](#). *NIPS 2012*, Lake Tahoe, Nevada, December 3-7, 2012.
- [42] Peder A. Olsen, Steven J. Rennie and Vaibhava Goel **Efficient automatic differentiation of matrix functions.** *Recent Advances in Algorithmic Differentiation*, p. 71-81, Springer Berlin Heidelberg, 2012.
- [43] Peder A. Olsen, Jing Huang, Steven J. Rennie and Vaibhava Goel Affine invariant sparse maximum a posteriori adaptation *ICASSP 2012*, p. 4317–4320, Kyoto, Japan, March 25-30, 2012.
- [44] Peder A. Olsen, Jing Huang, Vaibhava Goel and Steven J. Rennie Sparse maximum a posteriori adaptation *ASRU 2011*, p. 53–58, Big Island, Hawaii, USA, December 11-15, 2011.
- [45] Xiaodong Cui, Xin Chen, Jian Xue, Peder A. Olsen, John R. Hershey and Bowen Zhou, Acoustic modeling with bootstrap and restructuring based on full covariance. *Interspeech 2011*, p. 1697–1700, Florence, Italy, 28-31 August 2011.
- [46] Dimitri Kanevsky, Tara N. Sainath, David Nahamoo, Bhuvana Ramabhadran, Peder A. Olsen, A-functions: a generalization of extended Baum-Welch transformations to convex optimization. *ICASSP 2011*, p. 5164-5167, Prague, Czech Republic, 22-27 May 2011.
- [47] Xin Chen, Xiaodong Cui, Jian Xue, Peder Olsen, John Hersey, Bowen Zhou and Yunxin Zhao, Clustering of bootstrapped acoustic model with full covariance. *ICASSP 2011*, p. 4496-4499, Prague, Czech Republic, 22-27 May 2011.
- [48] Jing Huang, Karthik Visweswarah, Peder Olsen, Vaibhava Goel, Front-end feature transforms with context filtering for speaker adaptation. *ICASSP 2011*, p. 4440-4443, Prague, Czech Republic, 22-27 May 2011.
- [49] Shilei Zhang, Peder A. Olsen, Yong Qin, Rapid feature space MLLR speaker adaptation with bilinear models. *ICASSP 2011*, p. 4452-4455, Prague, Czech Republic, 22-27 May 2011.
- [50] Peder A. Olsen, Vaibhava Goel and Steven J. Rennie, Discriminative training for full covariance models. *ICASSP 2011*, p. 5312-5315, Prague, Czech Republic, 22-27 May 2011.
- [51] John R. Hershey, Peder A. Olsen and Steven J. Rennie, Signal interaction and the devil function. *Interspeech 2010*, p. 334-337, Makuhari, Japan, September 2010.
- [52] Vaibhava Goel, Tara N. Sainath, Bhuvana Ramabhadran, Peder A. Olsen, David Nahamoo and Dimitri Kanevsky, Incorporating sparse representation phone identification features in automatic speech recognition using exponential families. *Interspeech 2010*, p. 1345-1348, Makuhari, Japan, September 2010.
- [53] Pierre L. Dognin, John R. Hershey, Vaibhava Goel, and Peder A. Olsen, Restructuring exponential family mixture models. *Interspeech 2010*, p. 62-65, Makuhari, Japan, September 2010.
- [54] Peder Olsen, Vaibhava Goel, Charles Micchelli, and John Hershey, Modeling posterior probabilities using the linear exponential family. *Interspeech 2010*, p. 2994-2997, Makuhari, Japan, September 2010.
- [55] Pierre L. Dognin, John R. Hershey, Vaibhava Goel, and Peder A. Olsen, Restructuring acoustic models for client and server based automatic speech recognition. *Spoken Query Workshop, ICASSP 2010*, Dallas, Texas, March 2010.

- [56] Steven J. Rennie, John R. Hershey and Peder A. Olsen, Hierarchical variational loopy belief propagation for multi-talker speech recognition. *ASRU 2009*, p. 176-181, Merano, Italy, Dec. 2009.
- [57] Etienne Marcheret, Vaibhava Goel and Peder A. Olsen, Optimal quantization and bit allocation for compressing large discriminative feature space transforms. *ASRU 2009*, p. 64-69, Merano, Italy, Dec. 2009.
- [58] Pierre Dognin, John Hershey, Vaibhava Goel and Peder Olsen, Refactoring acoustic models using variational expectation-maximization. *Interspeech 2009*, p. 212-215, September 6-10, Brighton, UK.
- [59] Vaibhava Goel and Peder Olsen, Acoustic modeling using exponential families. *Interspeech 2009*, p. 1423-1426, September 6-10, Brighton, UK.
- [60] Etienne Marcheret, Jia-Yu Chen, Petr Fousek, Peder Olsen and Vaibhava Goel, Compacting discriminative feature space transforms for embedded devices. *Interspeech 2009*, p. 228-231, September 6-10, Brighton, UK.
- [61] Steven J. Rennie, John R. Hershey and Peder A. Olsen Variational loopy belief propagation for efficient multi-talker speech recognition. *Interspeech 2009*, p. 1331-1334, September 6-10, Brighton, UK.
- [62] Steven Rennie, John Hershey and Peder Olsen, Single-channel speech separation and recognition using loopy belief propagation. *ICASSP 2009*, p. 3845-3848, April 19-24, 2009, Taipei, Taiwan.
- [63] Pierre L. Dognin, Vaibhava Goel, Peder A. Olsen and John R. Hershey A fast, accurate approximation to log likelihood of Gaussian mixture models. *ICASSP 2009*, p. 3817-3820, April 19-24, 2009, Taipei, Taiwan.
- [64] Pierre L. Dognin, John R. Hershey, Vaibhava Goel and Peder Olsen, Refactoring acoustic models using variational density approximation. *ICASSP 2009*, p. 4473-4476, April 19-24, 2009, Taipei, Taiwan.
- [65] Jia-Yu Chen, John Hershey, Peder Olsen and Emmanuel Yashchin, Accelerated Monte Carlo for Kullback-Leibler divergence between gaussian mixture models. *ICASSP 2008*, p. 4553-4556, March 30 - April 4, Las Vegas, Nevada.
- [66] John Hershey and Peder Olsen, Variational Bhattacharyya divergence for hidden Markov models. *ICASSP 2008*, p. 4557-4560, March 30 - April 4, Las Vegas, Nevada.
- [67] Binit Mohanty, John R. Hershey, Peder A. Olsen, Suleyman S. Kozat and Vaibhava Goel, Optimizing speech recognition grammars using a measure of similarity between hidden Markov models. *ICASSP 2008*, p. 4593-4596, March 30 - April 4, Las Vegas, Nevada.
- [68] Steven J. Rennie, John Hershey and Peder Olsen, Efficient model-based speech separation and denoising using non-negative subspace analysis. *ICASSP 2008*, p. 1833-1836, March 30 - April 4, Las Vegas, Nevada.
- [69] John R. Hershey, Peder A. Olsen and Steven J. Rennie, Variational Kullback-Leibler divergence for hidden Markov models. *ASRU 2007*, p. 323-328, December 9-13, Kyoto, Japan.
- [70] Peder Olsen and John Hershey, Bhattacharyya error and divergence using variational importance sampling. *Interspeech 2007*, p. 46-49, August 27-31, 2007, Antwerp, Belgium.
- [71] Jia-Yu Chen, Peder Olsen and John Hershey, Word confusability - measuring hidden Markov model similarity. *Interspeech 2007*, p. 2089-2092, August 27-31, 2007, Antwerp, Belgium.
- [72] John Hershey and Peder Olsen, **Approximating the Kullback Leibler divergence between gaussian mixture models.** *ICASSP 2007, IV*, p. 317-320, April 15-20, 2007, Honolulu, Hawaii.
- [73] John Hershey, Peder Olsen and Ramesh Gopinath, Variational sampling approaches to word confusability. *Information Theory and Applications*, February 2007, San Diego, USA.
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- [76] Trausti Kristjansson, John Hershey, Peder Olsen, Steven Rennie and Ramesh Gopinath, Super-human multi-talker speech recognition: The IBM 2006 speech separation challenge system. *Interspeech 2006 ICSP*, 97-100, 17-21 September, 2006, Pittsburgh, Pennsylvania.
- [77] Steven Rennie, Trausti Kristjansson, Peder Olsen and Ramesh Gopinath, Dynamic noise adaptation. *ICASSP 2006*, **I**, 1197-1200, vol I, May 14-19, 2006, Toulouse, France.
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- [79] Trausti Kristjansson, Sabine Deligne and Peder Olsen. Voicing features for robust speech detection. *Interspeech 2005*, 369–372, September, 2005, Lisbon, Portugal.
- [80] Trausti Kristjansson, Sabine Deligne and Peder Olsen. Voicing features for robust speech detection. *Interspeech 2005*, 369–372, September, 2005, Lisbon, Portugal.
- [81] Peder A. Olsen, Karthik Viswesvariah and Ramesh Gopinath. Initializing subspace constrained gaussian mixture models. *IEEE International Conference on Acoustics, Speech and Signal Processing*, **I**:661-664, March, 2005, Philadelphia, Pennsylvania, USA.
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- [86] Scott Axelrod, Ramesh Gopinath, Peder Olsen and Karthik Viswesvariah. Dimensional reduction, covariance modeling and computational complexity in ASR systems. *IEEE International Conference on Acoustics, Speech and Signal Processing*, **I**:912–915, Hong Kong, April 2003.
- [87] Karthik Viswesvariah, Peder Olsen, Ramesh Gopinath and Scott Axelrod. Maximum likelihood training of subspaces for inverse covariance modeling. *IEEE International Conference on Acoustics, Speech and Signal Processing*, **I**:896–899, Hong Kong, April 2003.
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