Michael I Mandel

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Current position

Assistant Professor, Computer & Information Science, Brooklyn College (CUNY).
Faculty in the Computer Science PhD Program at the CUNY Graduate Center.

Research interests

Audio source separation and noise suppression
Noise robust automatic speech recognition
Psychoacoustics of speech perception in noise
Music understanding and similarity

Education

2010 Feb — PhD with distinction in Electrical Engineering, Columbia University
- Dissertation: "Binaural Model-Based Source Separation and Localization"
- Committee: Daniel Ellis (advisor), Barbara Shinn-Cunningham, Shih-Fu Chang, Richard Stern, Xiaodong Wang

2008 May — MPhil in Electrical Engineering, Columbia University

2006 Feb — MS in Electrical Engineering, Columbia University, GPA: 4.1/4.0

2004 Jun — BS in Computer Science and Engineering, MIT, GPA: 4.9/5.0

Academic positions

2015 – present — **Brooklyn College, CUNY**, Computer & Information Science, Assistant Professor

2015 – present — **Graduate Center, CUNY**, Computer Science PhD Program, Assistant Professor

2015 Jul–Aug — **Jelenik Speech and Language Technologies Workshop**, Far-field Speech team, Senior member

2012 – 2015 — **The Ohio State University**, Computer Science & Eng., Research Scientist

2014 May–Jun — **Télécom ParisTech**, Signal & Image Processing, Visiting professor, AAO Group

2009 – 2010 — **Université de Montréal**, Département d'informatique et de recherche opérationnelle, Postdoctoral researcher, LISA Lab

2004 – 2009 — **Columbia University**, Electrical Engineering, Research Assistant, LabROSA

2008 May–Jun — **Boston University**, Cog. & Neur. Sys., Visiting scholar, Shinn-Cunningham Lab

2003 – 2004 — **MIT**, CS/AI Lab, Undergraduate RA for Prof Bill Freeman

2002 – 2004 — **MIT**, MediaLab, Undergraduate RA for Prof Barry Vercoe

Work experience

2010 – 2012 — **Audience, Inc**, Mountain View, CA, Algorithm developer

2009 – 2010 — **Musically Intelligent Machines LLC**, New York, NY, Founder, CEO

2007 Jun–Aug — **Google, Inc.**, New York, NY, Software Engineering Intern, Google News

2006 Mar–Sep — **Owl Multimedia**, New York, NY, Co-founder, Dir. Technology

2004 Jun–Aug **Bose Corporation**, Framingham, MA, Research intern, uMusic™ project

Publications

Journal

M. I. Mandel, S. E. Yoho, and E. W. Healy, "Measuring time-frequency importance functions of speech with bubble noise," *Journal of the Acoustical Society of America*, 2016. To appear.

H. Larochelle, M. Mandel, R. Pascanu, and Y. Bengio, "Learning algorithms for the classification restricted boltzmann machine," *Journal of Machine Learning Research*, vol. 13, pp. 643–669, Mar. 2012.

J. Devaney, M. I. Mandel, D. P. W. Ellis, and I. Fujinaga, "Automatically extracting performance data from recordings of trained singers," *Psychomusicology: Music, Mind & Brain*, vol. 21, no. 1-2, pp. 108–136, 2012.

M. I. Mandel, R. Pascanu, D. Eck, Y. Bengio, L. M. Aiello, R. Schifanella, and F. Menczer, "Contextual tag inference," *ACM Transactions on Multimedia Computing, Communications and Applications*, vol. 7S, pp. 32:1–32:18, Oct. 2011.

R. Weiss, M. I. Mandel, and D. P. W. Ellis, "Combining localization cues and source model constraints for binaural source separation," *Speech Communication*, vol. 53, pp. 606–621, May 2011.

M. I. Mandel, S. Bressler, B. Shinn-Cunningham, and D. P. W. Ellis, "Evaluating source separation algorithms with reverberant speech," *IEEE Transactions on Audio, Speech, and Language Processing*, vol. 18, no. 7, pp. 1872–1883, 2010.

M. I. Mandel, R. J. Weiss, and D. P. W. Ellis, "Model-based expectation maximization source separation and localization," *IEEE Transactions on Audio, Speech, and Language Processing*, vol. 18, pp. 382–394, Feb. 2010.

M. I. Mandel and D. P. W. Ellis, "A web-based game for collecting music metadata," *Journal of New Music Research*, vol. 37, no. 2, pp. 151–165, 2008.

T. S. Huang, C. K. Dagli, S. Rajaram, E. Y. Chang, M. I. Mandel, G. E. Poliner, and D. P. W. Ellis, "Active learning for interactive multimedia retrieval," *Proceedings of the IEEE*, vol. 96, no. 4, pp. 648–667, 2008.

M. I. Mandel, G. E. Poliner, and D. P. W. Ellis, "Support vector machine active learning for music retrieval," *Multimedia systems*, vol. 12, pp. 1–11, Aug. 2006.

Books, Chapters, Theses

J. Devaney, M. I. Mandel, D. Turnbull, and G. Tzanetakis, eds., *Proceedings of the 17th International Society for Music Information Retrieval Conference (ISMIR)*. 2016.

M. I. Mandel, *Binaural Model-Based Source Separation and Localization*. PhD thesis, Columbia University, Feb. 2010.

T. Bertin-Mahieux, D. Eck, and M. I. Mandel, "Automatic tagging of audio: The state-of-the-art," in *Machine Audition: Principles, Algorithms and Systems* (W. Wang, ed.), ch. 14, pp. 334–352, IGI Publishing, 2010.

Conference

M. I. Mandel and J. P. Barker, "Multichannel spatial clustering for robust far-field automatic speech recognition in mismatched conditions," in *Proceedings of Interspeech*, pp. 1991–1995, 2016.

M. I. Mandel, "Directly comparing the listening strategies of humans and machines," in *Proceedings of Interspeech*, pp. 660–664, 2016.

H. Erdogan, J. Hershey, S. Watanabe, M. Mandel, and J. L. Roux, "Improved MVDR beamforming using single-channel mask prediction networks," in *Proceedings of Interspeech*, pp. 1981–1985, 2016.

X. Xiao, S. Watanabe, H. Erdogan, L. Lu, J. Hershey, M. L. Seltzer, G. Chen, Y. Zhang, M. Mandel, and D. Yu, "Deep beamforming networks for multi-channel speech recognition," in *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing*, pp. 5745–5749, IEEE, mar 2016.

D. Bagchi, M. I. Mandel, Z. Wang, Y. He, A. Plummer, and E. Fosler-Lussier, "Combining spectral feature mapping and multi-channel model-based source separation for noise-robust automatic speech recognition," in *Proceedings of the IEEE Workshop on Automatic Speech Recognition and Understanding*, 2015.

M. I. Mandel and Y. S. Cho, "Audio super-resolution using concatenative resynthesis," in *IEEE Workshop on Applications of Signal Processing to Audio and Acoustics*, 2015.

S. S. Tirumala and M. I. Mandel, "Exciting estimated clean spectra for speech resynthesis," in *IEEE Workshop on Applications of Signal Processing to Audio and Acoustics*, 2015.

M. I. Mandel and N. Roman, "Enforcing consistency in spectral masks using markov random fields," in *Proceedings of EUSIPCO*, 2015.

M. I. Mandel, Y.-S. Cho, and Y. Wang, "Learning a concatenative resynthesis system for noise suppression," in *Proceedings of the IEEE GlobalSIP conference*, 2014.

M. I. Mandel, S. E. Yoho, and E. W. Healy, "Generalizing time-frequency importance functions across noises, talkers, and phonemes," in *Proceedings of Interspeech*, 2014.

M. I. Mandel and A. Narayanan, "Analysis-by-synthesis feature estimation for robust automatic speech recognition using spectral masks," in *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing*, 2014.

A. Nandi, L. Jiang, and M. Mandel, "Gestural query specification," in *Proceedings of the International Conference on Very Large Data Bases*, vol. 7, 2014.

M. I. Mandel, "Learning an intelligibility map of individual utterances," in *IEEE Workshop on Applications of Signal Processing to Audio and Acoustics*, 2013.

N. Roman and M. Mandel, "Classification based binaural dereverberation," in *Proceedings of Interspeech*, 2013.

J. Devaney, M. I. Mandel, and I. Fujinaga, "A study of intonation in three-part singing using the automatic music performance analysis and comparison toolkit (AMPACT)," in *Proceedings of the International Society for Music Information Retrieval conference*, 2012.

J. Devaney, M. I. Mandel, and I. Fujinaga, "Characterizing singing voice fundamental frequency trajectories," in *IEEE Workshop on Applications of Signal Processing to Audio and Acoustics*, pp. 73–76, Oct. 2011.

M. I. Mandel, D. Eck, and Y. Bengio, "Learning tags that vary within a song," in *Proceedings of the International Society for Music Information Retrieval conference*, pp. 399–404, Aug. 2010.

J. Bergstra, M. I. Mandel, and D. Eck, "Scalable genre and tag prediction with spectral covariance," in *Proceedings of the International Society for Music Information Retrieval conference*, pp. 507–512, Aug. 2010.

E. Law, K. West, M. Mandel, M. Bay, and J. S. Downie, "Evaluation of algorithms using games: the case of music annotation," in *Proceedings of the International Society for Music Information Retrieval conference*, pp. 387–392, Oct. 2009.

M. I. Mandel and D. P. W. Ellis, "The ideal interaural parameter mask: a bound on binaural separation systems," in *IEEE Workshop on Applications of Signal Processing to Audio and Acoustics*, pp. 85–88, Oct. 2009.

J. Devaney, M. I. Mandel, and D. P. W. Ellis, "Improving MIDI-audio alignment with acoustic features," in *IEEE Workshop on Applications of Signal Processing to Audio and Acoustics*, pp. 45–48, Oct. 2009.

R. J. Weiss, M. I. Mandel, and D. P. W. Ellis, "Source separation based on binaural cues and source model constraints," in *Proceedings of Interspeech*, pp. 419–422, Sept. 2008.

M. I. Mandel and D. P. W. Ellis, "Multiple-instance learning for music information retrieval," in *Proceedings of the International Society for Music Information Retrieval conference*, pp. 577–582, Sept. 2008.

D. P. W. Ellis, C. V. Cotton, and M. I. Mandel, "Cross-correlation of beat-synchronous representations for music similarity," in *Proceedings of the IEEE International Conference on Acoustics, Speech, and Signal Processing*, pp. 57–60, Apr. 2008.

M. I. Mandel and D. P. W. Ellis, "EM localization and separation using interaural level and phase cues," in *IEEE Workshop on Applications of Signal Processing to Audio and Acoustics*, pp. 275–278, Oct. 2007.

M. I. Mandel and D. P. W. Ellis, "A web-based game for collecting music metadata," in *Proceedings of the International Society for Music Information Retrieval conference* (S. Dixon, D. Bainbridge, and R. Typke, eds.), pp. 365–366, Sept. 2007.

M. I. Mandel, D. P. W. Ellis, and T. Jebara, "An EM algorithm for localizing multiple sound sources in reverberant environments," in *Advances in Neural Information Processing Systems* (B. Schölkopf, J. Platt, and T. Hoffman, eds.), pp. 953–960, Cambridge, MA: MIT Press, 2007.

M. I. Mandel and D. P. W. Ellis, "Song-level features and support vector machines for music classification," in *Proceedings of the International Society for Music Information Retrieval conference* (J. D. Reiss and G. A. Wiggins, eds.), pp. 594–599, Sept. 2005.

E. B. Sudderth, M. I. Mandel, W. T. Freeman, and A. S. Willsky, "Distributed occlusion reasoning for tracking with nonparametric belief propagation," in *Advances in Neural Information Processing Systems* (L. K. Saul, Y. Weiss, and L. Bottou, eds.), pp. 1369–1376, Cambridge, MA: MIT Press, 2005.

Other

M. I. Mandel and N. Roman, "Integrating markov random fields and model-based expectation maximization source separation and localization," in *Acoustical Society of America Spring Meeting*, 2015.

M. I. Mandel, S. E. Yoho, and E. W. Healy, "Listener consistency in identifying speech mixed with particular bubble noise instances," in *Acoustical Society of America Spring Meeting*, 2015.

M. I. Mandel and S. H. Chon, "Using auditory bubbles to determine spectro-temporal cues of timbre," in *Cognitively Based Music Informatics Research (Cog-MIR)*, 2014.

A. Nandi and M. Mandel, "The interactive join: Recognizing gestures for database queries," in *CHI Works-In-Progress*, 2013.

M. Mandel, R. Pascanu, H. Larochelle, and Y. Bengio, "Autotagging music with conditional restricted boltzmann machines," Mar. 2011. Online: http://arxiv.org/abs/1103.2832.

M. I. Mandel and D. P. W. Ellis, "A probability model for interaural phase difference," in *ISCA Workshop on Statistical and Perceptual Audio Processing SAPA*, pp. 1–6, 2006.

E. B. Sudderth, M. I. Mandel, W. T. Freeman, and A. S. Willsky, "Visual hand tracking using nonparametric belief propagation," in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition Workshops*, pp. 189–197, 2004.

Funding

National Science Foundation Award IIS-1618061, June 2016 – May 2019. "RI: Small: Concatenative Resynthesis for Very High Quality Speech Enhancement." PI: Michael Mandel. $449,958.

PSC-CUNY Research Award, Trad-B Project #69638-00 47, July 2016, "A game for identifying important speech cues." PI: Michael Mandel. $5,931.

Google Research Award, February 2016, "Incorporating a speech model into multichannel spatial clustering." PI: Michael Mandel. $50,430.

National Endowment for the Humanities Award HD-228966-15, May 2015 – October 2016. "Automatic Music Performance Analysis and Comparison Toolkit (AMPACT): An empirical exploration of expressive musical performance." PI: Johanna Devaney. Co-PI: Michael Mandel. $59,843

National Science Foundation Award IIS-1409431, June 2014 – May 2017. "RI: Medium: Deep Neural Networks for Robust Speech Recognition through Integrated Acoustic Modeling and Separation." PI: Eric Fosler-Lussier, Co-PIs: Michael Mandel and DeLiang Wang. $798,082.

Google Research Award, August 2013, "Learning to recognize sounds for separation." PI: Michael Mandel. $49,308.

Teaching

CUNY Graduate Center, Computer Science Program

2016 Fall	83060: Speech and Audio Understanding, Instructor, 9 PhD students

Brooklyn College, Department of Computer and Information Science

2016 Spring	7610X: Multimedia databases, Instructor, 12 masters students
2016 Spring	1600: Intro. to Multimedia Computing, Instructor, 35 undergraduate students
2015 Fall	1600: Intro. to Multimedia Computing, Instructor, 32 undergraduate students

The Ohio State University, Department of Computer Science and Engineering

2014 Fall — 5226: Neural networks, Instructor, 25 masters students

6539: Speech & language reading group, Co-instructor, 16 students

2014 Spring — 6539: Speech & language reading group, Co-instructor, 10 students

2013 Fall — 6539: Speech & language reading group, Co-instructor, 11 students

2013 July — Machine learning, Sennheiser Technology & Innovation Center, Instructor

- 5-day course for 8 Sennheiser employees
- Designed course, created materials, presented lectures and labs

Columbia University, Department of Electrical Engineering

2009 Spring — 6820: Speech & audio processing & recognition, Co-lecturer, 7 students

2008 Fall — 4810: Digital Signal Processing, Teaching Assistant, 60 masters students

2008 Summer — 6820: Speech & audio processing & recognition, Manager, 5 PhD students

2008 Spring — 6820: Speech & audio processing & recognition, Co-lecturer, 9 PhD students

Students

CUNY, PhD students

2016 – Felix Grezes, Min Ma, Soumi Maiti, Ali Raza Syed, Trinh Viet Anh

Brooklyn College, Undergraduate students

2016 – Alex Aquino, Eugene Chen, Heriberto Cortes, Renee Esses, Klanti Islam, Max Ohsawa, Max Shteyman

The Ohio State University, PhD students

2013 – 2015 — Young Suk Cho, Computer Science and Engineering, Independent study and Research Assistantship, "Learning to recognize sounds for separation."

The Ohio State University, MS students

2015 – Sreyas Srimath Tirumala, Computer Science and Engineering, Research Assistantship, "Parametric speech models for analysis-by-synthesis noise robustness."

The Ohio State University, Undergraduates

2015 — Thomas Lyons, Electrical and Computer Engineering, independent study, "Improving classification performance for auditory bubbles of musical timbre."

2014 — Benjamin Oberhaus, Computer Science and Engineering, recipient of Research Scholar Award, independent study, "A deep learning approach to source separation for music tracks."

2014 – 2015 — Rachel Nelson, Computer Science and Engineering, independent study, "Browser-based auditory bubbles game."

2013 – 2014 — Austin Mackey, Engineering Physics; Kyle MacNicholas, Electrical and Computer Engineering; Erik Ringman, Engineering Physics, Santosh Kantharaj, Computer Science and Engineering; Engineering Physics capstone project, "Buckeye-Verb."

2012 – 2013 — Jordan Hawkins, Electrical and Computer Engineering, Honors Research Thesis, "Automating Music Production with Music Information Retrieval."

Awards

Outstanding undergraduate research mentor, Ohio State University, 2013

Postdoctoral research fellowship, Le Fonds québécois de la recherche sur la nature et les technologies, Merit Scholarship Program for Foreign Students 2009–2010, $35,000

Dissertation with distinction, top 10% of Columbia dissertations

Presidential Fellowship, Columbia University School of Engineering and Applied Sciences, 2004–2009, $116,700 plus tuition:

- Sep 2004 – Aug 2005: $30,000 + 2 semesters' tuition
- Sep 2005 – May 2006: $22,500 + 2 semesters' tuition
- Jan 2007 – May 2007: $14,600 + 1 semester's tuition
- Sep 2007 – Aug 2008: $35,000 + 2 semesters' tuition
- Jan 2009 – May 2009: $14,600 + 1 semester's tuition

Second place, Columbia Venture Competition 2009, Columbia University School of Enchineering and Applied Sciences, $7,000

First place, Music Information Retrieval Evaluation eXchange 2008 Audio Artist and Classical Composer Identification task. Tied for first place in Audio Tag Classification task.

First place, Music Information Retrieval Evaluation eXchange 2005 Audio Artist Identification.

Honorable mention, NSF Graduate Research Fellowship Program, 2004.

Top 5% of 180 students in 6.003: Signals and Systems, May 2002.

Emerson Music Scholarship to study saxophone with Jeff Harrington at the Berklee School of Music, 2001–2002 and 2002–2003, $1,200 total.

Invited talks

2015 Oct 22	Speech and Audio in the Northeast (SANE) Workshop, "Multichannel spatial clustering at the 2015 Jelenik Workshop on Speech and Language Technologies"
2015 Jun 29	Jelenik Speech and Language Technologies Summer School, "Noise robustness in Automatic Speech Recognition"
2015 Mar 20	CCRMA Hearing Seminar, "Auditory bubbles: Estimating time frequency importance functions"
2015 Mar 18	Google, "Analysis-by-synthesis for speech recognition and source separation"
2015 Jan 28	University of Illinois, Urbana-Champaign, "Detailed models for understanding speech in noise"
2014 Jul 11	McMaster University, "Auditory bubbles: Estimating time frequency importance functions"
2014 Jun 25	École Normal Supérieure, "Auditory bubbles: Estimating time frequency importance functions"
2014 Jun 13	Sheffield University, "Detailed models for understanding speech in noise"
2014 May 2	Queen Mary University London, "Strong models for understanding sounds in mixtures"
2014 Feb 12	Toyota Technological Institute, Chicago, "Detailed models for understanding speech in noise"

2014 Feb 7	Mitsubishi Electric Research Labs, “Detailed models for understanding speech in noise”
2014 Jan 15	Dartmouth Computer Science Colloquium, “Context-dependent models for understanding speech in noise”
2013 Nov 15	CIRMMT Workshop on symbolic music processing, semantic audio, and music information retrieval, “Extracting descriptive tags from audio using restricted Boltzmann machines”
2013 Apr 30	Telecom ParisTech, “Model-based source separation in reverberant mixtures”
2012 Oct 6	First Samsung Intenational Symposium on Hearing Aids, “Model based source separation”
2012 June 29	CCRMA Music Information Retrieval Workshop 2012, “Training automatic music taggers”
2012 May 11	CCRMA Hearing Seminar, “Evaluating reverberant source separation”
2010 Apr 19	Google, “Training automatic music taggers”
2009 Nov 25	New York University, “Automatically describing music”
2009 Oct 16	Drexel University, “Binaural Model-based Source Separation and Localization”
2008 Dec 15	Last.fm, “MajorMiner: Automatically describing music”
2008 Dec 15	Cambridge University, “Model-based EM source separation and localization in reverberant mixtures.”
2008 Dec 10	Sheffield University, “Model-based EM source separation and localization in reverberant mixtures.”
2008 Nov 5	Dorkbot NYC, “MajorMiner: Automatically describing music”
2008 Nov 4	McGill University, Music Technology Student Colloquium, “MajorMiner: Automatically describing music”
2008 Jun 13	Boston University Hearing Research Seminar, “Model-based EM source separation and localization in reverberant mixtures.”
2008 Feb 18	Université de Montréal, “Model-based EM source separation and localization.”
2007 Nov 16	New York University, “EM localization and separation using interaural level and phase cues.”
2007 Oct 9	Université de Montréal, “EM localization and separation using interaural level and phase cues.”

Other contributions

Service	Publications chair, International Society of Music Information Retrieval Conference, 2016
	Lead Organizer and moderator for the panel “The Future of Audio Multimedia” with Gerald Friedland at ACM Multimedia 2014, panelists Dan Ellis, Gerald Friedland, Youngmoo Kim, Josh McDermott, and Paris Smaragdis.
	Organizer for the OSU CSE AI Seminar, Jan 2012 – Aug 2015
	Publicity chair for the IEEE Workshop on Applications of Signal Processing to Audio and Acoustics, Oct 2011

Co-organizer of the Montreal Music and Machine Learning workshop at the Université de Montréal, Nov 2008

Co-founder of the 2008 Columbia Electrical Engineering Signal and Information Processing Seminar Series (EESIP SS), 2008 organizer

Tutorial and panel chair, ISMIR 2008

Co-organizer of the Audio Tag Classification task, Music Information Retrieval Evaluation eXchange (MIREX) 2008

Co-founder of the North Eastern Music Information Special Interest Group (NEMISIG), 2007 co-organizer

Program Committees

2016 International Conference on Machine Learning
2016 International Society for Music Information Retrieval Conference
2016 Annual Conference of the International Speech Communication Association (Interspeech)
2016 Speech Processing in Everyday Environments Workshop at Interspeech
2015 IEEE Workshop on Applications of Signal Processing to Audio & Acoustics

Journal Reviews

- IEEE Transactions in Audio Speech and Language Processing, 2007–16
- IEEE Transactions on Multimedia, 2010–16
- IEEE Transactions on Signal Processing, 2013–15
- ACM Transactions on Knowledge and Data Engineering, 2013
- Journal of the Acoustical Society of America, 2012–13
- Journal of the Acoustical Society of America Express Letters, 2013–2016
- Speech Communication, 2012–15
- EURASIP Journal on Audio, Speech, and Music Processing, 2012–13
- IEEE Signal Processing Letters, 2010–15

Conference Reviews

- Intl. Conference on Learning Representations, 2013–16
- IEEE Intl. Conference on Audio Speech and Signal Processing, 2006–16
- Intl. Society of Music Information Retrieval Conference, 2006–15
- Annual Conference of the Intl. Speech Communication Association (INTERSPEECH), 2014–2015
- Intl. Conference on Machine Learning, 2013–14
- Intl. Conference on Very Large Data Bases 2013
- IEEE Intl. Conference on Emerging Signal Processing Applications, 2011

Associations

- IEEE Student member 2007–2009, Member 2010–present
- ACM Member 2013–present
- Acoustical Society of America, associate member 2015–present
- Society for Music Theory, joint member, 2015–present

Brooklyn, September 25, 2016