

# Michael I Mandel

**Contact information**  
mim @ ee columbia edu  
http://mr-pc.org  
347-881-6165

**School address**  
Dept Comp Sci & Ops Res, Univ Montréal  
CP 6128, Succ. Centre-Ville  
Montréal, Québec, H3C 3J7, Canada

## Current position

Postdoctoral researcher in the department of Computer Science at the Université de Montréal. Working in the Laboratoire d'Informatique des Systèmes Adaptatifs (LISA, Machine Learning Lab) under the supervision of Profs Douglas Eck and Yoshua Bengio.

## Research interests

Music, speech, and audio processing and understanding  
Machine learning, especially Bayesian methods and deep architectures  
Computational auditory scene analysis and source separation  
Music recommendation and similarity, music information retrieval  
Computational music analysis

## Education

- 2010 Feb PhD with distinction in Electrical Engineering, Columbia University
- Dissertation: “Binaural Model-Based Source Separation and Localization”
  - Committee: Daniel Ellis (advisor), Shih-Fu Chang, Barbara Shinn-Cunningham, 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
  - Relevant course work: Bayesian Data Analysis, Detection / Estimation Theory, Advanced Machine Learning, Computational Imaging, Speech Recognition
- 2004 Jun BS in Computer Science and Engineering, Massachusetts Institute of Technology
- GPA: 4.9/5.0
  - Relevant course work: Intro to Communication, Control, and Signal Processing, Applied Probability, Machine Vision, The Human Intelligence Enterprise, Audio Processing by Humans and Machines

## Publications

- Book chapter 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.), IGI Publishing, 2010. In press.
- Journal 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*, 2010. Submitted.

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, August 2006.

Conference

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 10th International Conference on Music Information Retrieval (ISMIR)*, pp. 387–392, October 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 (WASPAA)*, pp. 85–88, October 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 (WASPAA)*, pp. 45–48, October 2009.

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

M. I. Mandel and D. P. W. Ellis, "Multiple-instance learning for music information retrieval," in *Proceedings of the 9th International Conference on Music Information Retrieval (ISMIR)*, pp. 577–582, September 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 (ICASSP)*, pp. 57–60, April 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 (WASPAA)*, pp. 275–278, October 2007.

M. I. Mandel and D. P. W. Ellis, "A web-based game for collecting music metadata," in *Proceedings of the 8th International Conference on Music Information Retrieval (ISMIR)* (S. Dixon, D. Bainbridge, and R. Typke, eds.), pp. 365–366, September 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 19* (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 6th International Conference on Music Information Retrieval (ISMIR)* (J. D. Reiss and G. A. Wiggins, eds.), pp. 594–599, September 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 17* (L. K. Saul, Y. Weiss, and L. Bottou, eds.), pp. 1369–1376, Cambridge, MA: MIT Press, 2005.

Workshop

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.

**Awards**

**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:

- 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 Engineering 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.

**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.

**Teaching**

*Columbia University, Department of Electrical Engineering*

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|-------------|---|
| 2009 Spring | ELEN 6820: Speech and audio processing and recognition, Co-lecturer <ul style="list-style-type: none"><li>• PhD-level course, 7 students</li><li>• Delivered 5 of 12 lectures, advised students on projects, graded homeworks</li></ul> |
| 2008 Fall   | ELEN 4810: Digital Signal Processing, Teaching Assistant <ul style="list-style-type: none"><li>• Masters-level course, 60 students</li><li>• Advised students on homeworks, provided tutorials, graded exams</li></ul>                  |
| 2008 Summer | ELEN 6820: Speech and audio processing and recognition, Course manager <ul style="list-style-type: none"><li>• Columbia Video Network: presented online using pre-recorded lectures</li></ul>   |

- PhD-level course, 5 students
  - Ran all aspects of course including grading and project advice
- 2008 Spring ELEN 6820: Speech and audio processing and recognition, Co-lecturer
- PhD-level course, 9 students
  - Delivered 5 of 12 lectures, advised students on projects, graded homeworks
  - Overhauled course materials including slides and reading list

## Invited talks

- 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.”

## Work experience

- 2009 – present **Université de Montréal**, Montreal, QC, Postdoctoral researcher, LISA Lab
- Investigating interesting machine learning problems in music.
- 2009 – present **Musically Intelligent Machines LLC**, New York, NY, Founder, CEO
- Developing technology to automatically describe music.
  - Running all aspects of business: marketing, sales, development, etc.
- 2004 – 2009 **Columbia University**, New York, NY, Research Assistant, LabROSA
- Applied machine learning to human-like sound source separation.
  - Studied music classification, music similarity, and playlist generation.
  - Visiting scholar at Boston University Department of Cognitive and Neural Systems, working with Prof Barbara Shinn-Cunningham, May – Jun, 2008.
- 2007 Jun–Aug **Google, Inc.**, New York, NY, Software Engineering Intern, Google News
- Designed and implemented continuously running news story-identification system in C++ using MapReduce and BigTable.
  - Designed and ran experiment to collect ground truth article similarity.
- 2006 Mar–Sep **Owl Multimedia**, New York, NY, Co-founder, Dir. Technology

- Designed and implemented client- and server-side feature extraction enabling audio-based music search.
  - Managed two developers on design and implementation of main site.
  - Administered and maintained database and web servers.
- 2004 Jun–Aug **Bose Corporation**, Framingham, MA, Research intern, uMusic™ project
- Conducted listening survey studying perceptual and emotional reactions to music.
  - Prototyped machine listening for uMusic™ system using survey data.
- 2003 – 2004 **MIT CS/AI Lab**, Cambridge, MA, Undergraduate RA for Prof Bill Freeman
- Built a Nonparametric Belief Propagation-based hand/finger tracker.
  - Coauthored papers published at NIPS 2004 and a CVPR 2004 workshop
  - Wrote Matlab, Mex, and C++ code for an NBP library, including parallelization.
- 2002 – 2004 **MIT MediaLab** Cambridge, MA, Undergraduate RA for Prof Barry Vercoe
- Developed analysis-by-synthesis transcription system using midi piano.
  - Explored algorithms for finding song structure via STFT frame similarity.
  - Developed an image quilting-like sound texture synthesizer.

## Skills

Software design and implementation in Python (including NumPy), Matlab, Java, C/C++ , Perl, Ruby, and Scheme.

Unix/Linux system administration (9 years).

Facility with MySQL, Rails, Apache, MS Windows,  $\text{\LaTeX}$ , Emacs

## Other contributions

- Services
- 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
- Reviews
- IEEE Transactions in Audio Speech and Language Processing, 2007–10
  - IEEE Intl. Conference on Audio Speech and Signal Processing, 2006–9
  - IEEE Multimedia Magazine, 2008
  - Intl. Conference on Music Information Retrieval, 2006–7, 2009
  - Statistical Analysis and Data Mining, 2007
  - Journal of Information Science and Engineering, 2006
  - ISCA Workshop on Statistical and Perceptual Audio Processing, 2006
  - Journal of New Music Research, 2005, 2009
- Associations
- IEEE Student member since 2007
- Websites
- <http://majorminer.org>
- First human computation game about describing music.

- Also allows search of human labels.

<http://blog.mr-pc.org>

- Research and personal blog.
- Active since 2005.

Montreal, January 3, 2010