

# Curriculum Vitæ

## Douglas Eck

Research Scientist, Music and Machine Learning  
Google, Mountain View CA, USA

## Contact

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## Affiliations

### **BRAMS Laboratory for Brain Music and Sound, University of Montreal**

BRAMS is an inter-university research laboratory for research in the neuroscience and psychology of music perception and cognition. Participating universities include University of Montreal, McGill, Concordia and the McGill Neurological Institute (MNI). See <http://www.brams.org>.

Function: Associate member (2011-present)  
Full member (2004-2011)  
Executive committee member (2007-2010)

### **CIRMMT Center for Interdisciplinary Research in Music Media and Tech, McGill University**

CIRMMT is a Canada research center focusing on music technology. CIRMMT facilities are at McGill, with members from several Montreal universities including University of Montreal. See <http://www.cirmmt.org>.

Function: Associate Member (2011-present)  
Full Member (2004-2011)  
Research axis co-leader for the Music Information Retrieval axis (2007-2011)  
Executive committee member (2007-2009)

### **LISA Machine Learning Laboratory, University of Montreal**

LISA is the University of Montreal Machine Learning laboratory comprising three faculty members, several postdoctoral researchers and technicians and > 20 graduate students. See <http://www.iro.umontreal.ca/~lisa>.

Function: Associate member (2011-present)  
Faculty member (2003-2011)

## Education

### **Postdoctoral Fellow (2000–2003)**

Dalle Molle Institute for Artificial Intelligence (IDSIA), Lugano Switzerland

Research: Sequence learning. Hybrid recurrent neural networks.  
Director: Juergen Schmidhuber.

### **Ph.D. Computer Science & Cognitive Science (2000)**

Indiana University, Bloomington

Dissertation: *Meter Through Synchrony: Processing Rhythmical Patterns with Relaxation Oscillators.*

**M.S. Computer Science (1996)**, Indiana University, Bloomington.

**B.A. English Literature (1991)**, Indiana University, Bloomington.

## Professional History

### Research Scientist (2010–present)

**Google, Mountainview, California, USA.**

Carrying out machine learning research in the domain of music. Developing new software and new interfaces for music exploration.

### Adjunct Faculty (2011–present), Associate Professor (2008–2011), Assistant Professor (2003–2008)

**University of Montreal Department of Computer Science, Montreal, Quebec, Canada.**

Director of the GAMME music and machine learning lab and faculty member of LISA machine learning lab; Built state-of-the-art music performance research lab at Intl. Laboratory for Brain, Music and Sound Research (BRAMS; [www.brams.org](http://www.brams.org)).

### Visiting Researcher (06/2009–01/2010)

**Ubisoft Entertainment, Montreal.**

Sabbatical research collaboration taking place at the Montreal video game design studios of Ubisoft. Launching project in machine learning for video games with three graduate students from the LISA machine learning lab. Focus areas include machine learning techniques for player modeling and for working with new controller interfaces.

### Visiting Professor (01/2007–07/2007)

**Sun Labs, Sun Microsystems, Boston, Mass, USA.**

Six month leave from University of Montreal to design machine learning algorithms for “Search Inside the Music” (SITM), a large-scale music recommender. See NIPS paper *Automatic generation of social tags for music recommendation* for details.

### Postdoctoral Research Fellow (2000–2003)

**Dalle Molle Institute for Artificial Intelligence (IDSIA), Lugano, Switzerland.**

Research areas included hybrid recurrent neural networks and spiking neural networks. Supervisor was Juergen Schmidhuber.

### Machine Learning Researcher (1999–2000)

**Motorola Ceramics Division, Albuquerque, New Mexico.**

Implemented and tested machine-learning-based control algorithm for robotic laser. Led team in collecting and analyzing data from Motorola manufacturing processes. Project details under nondisclosure.

## Organization and Professional Service

- Reviewer: Reviewed for most major journals and conferences in the fields of machine learning, signal processing and music cognition. Details on request.
- Guest Editor: *Music Perception* (Spring 2005 Special Issue Vol. 22 No. 3).
- Organizer : Sparse Methods for Music Audio Workshop, ICML; Summer 2009, Montreal.  
Expressive Performance Workshop, BRAMS; Summer 2009, Montreal.  
Machine Learning and Music Workshop, CIRMMT; McGill, Autumn 2008, Montreal.  
Music and Machine Learning Workshop, NIPS, Winter 2005, Vancouver.  
Rhythm Perception and Production Workshop (RPPW), Summer 2003, France.
- Boards : Member-at-large, Intl. Society for Music Information Retrieval (ISMIR), 2009-present
- Committees : Member, Executive Committee, CIRMMT, 2007-2009.  
Member, Executive Committee, BRAMS, 2006-present.

## Publications

### Articles in Refereed Publications

- [1] J. Paiement, S. Bengio, and D. Eck. Probabilistic models for melodic prediction. *Artificial Intelligence Journal*, 173:1266–1274, 2009.
- [2] T. Bertin-Mahieux, D. Eck, F. Maillet, and P. Lamere. Autotagger: A model for predicting social tags from acoustic features on large music databases. *Journal of New Music Research*, 37(2):115–135, 2008.
- [3] A. Lacoste and D. Eck. A supervised classification algorithm for note onset detection. *EURASIP Journal on Applied Signal Processing*, 2007(ID 43745):1–13, 2007.
- [4] D. Eck. Finding long-timescale musical structure with an autocorrelation phase matrix. *Music Perception*, 24(2):167–176, 2006.
- [5] J. Bergstra, N. Casagrande, D. Erhan, D. Eck, and B. Kégl. Aggregate features and AdaBoost for music classification. *Machine Learning*, 65(2-3):473–484, 2006.
- [6] J. Pérez-Ortiz, F. A. Gers, D. Eck, and J. Schmidhuber. Kalman filters improve LSTM network performance in problems unsolvable by traditional recurrent nets. *Neural Networks*, 16(2):241–250, 2003.
- [7] J. Schmidhuber, F. Gers, and D. Eck. Learning nonregular languages: A comparison of simple recurrent networks and LSTM. *Neural Computation*, 14(9):2039–2041, 2002.
- [8] D. Eck. Finding downbeats with a relaxation oscillator. *Psychol. Research*, 66(1):18–25, 2002.
- [9] D. Eck. A positive-evidence model for rhythmical beat induction. *Journal of New Music Research*, 30(2):187–200, 2001.
- [10] M. Gasser, D. Eck, and R. Port. Meter as mechanism: A neural network model that learns metrical patterns. *Connection Science*, 11(2):187–216, 1999.

### Conference Proceedings and Other Refereed Contributions

- [11] M. Mandel, D. Eck, and Y. Bengio. Learning tags that vary within a song. In *Proceedings of the 11th International Conference on Music Information Retrieval (ISMIR 2010)*, 2010.

- [12] P. Hamel and D. Eck. Learning features from music audio with Deep Belief Networks. In *Proceedings of the 11th International Conference on Music Information Retrieval (ISMIR 2010)*, 2010.
- [13] J. Bergstra, M. Mandel, and D. Eck. Scalable genre and tag prediction with spectral covariance. In *Proceedings of the 11th International Conference on Music Information Retrieval (ISMIR 2010)*, 2010.
- [14] B. Leonard, G. Sikora, M. D. Francisco, and D. Eck. Acoustic space sampling and the grand piano in a non-anechoic environment: a recordist-centric approach to musical acoustic study. In *129th Audio Engineering Society (AES) Convention*, London, 2010.
- [15] A. Courville, D. Eck, and Y. Bengio. An infinite factor model hierarchy via a noisy-or mechanism. In *Neural Information Processing Systems Conference 22 (NIPS'09)*, 2010.
- [16] F. Mailliet, D. Eck, G. Desjardins, and P. Lamere. Steerable playlist generation by learning song similarity from radio station playlists. In *Proceedings of the 10th International Conference on Music Information Retrieval (ISMIR 2009)*, 2009.
- [17] P. Hamel, S. Wood, and D. Eck. Automatic identification of instrument classes in polyphonic and poly-instrument audio. In *Proceedings of the 10th International Conference on Music Information Retrieval (ISMIR 2009)*, 2009.
- [18] M. Davies, M. Plumbley, and D. Eck. Towards a musical beat emphasis function. In *Proceedings of IEEE WASPAA*, New Paltz, NY, 2009. IEEE Workshop on Applications of Signal Processing to Audio and Acoustics.
- [19] J. Paiement, Y. Grandvalet, S. Bengio, and D. Eck. A generative model for rhythms. In *ICML '08: Proceedings of the 25th International Conference on Machine Learning*, 2008.
- [20] P.-A. Manzagol, T. Bertin-Mahieux, and D. Eck. On the use of sparse time relative auditory codes for music. In *Proceedings of the 9th International Conference on Music Information Retrieval (ISMIR 2008)*, 2008.
- [21] D. Eck, P. Lamere, T. Bertin-Mahieux, and S. Green. Automatic generation of social tags for music recommendation. In *Neural Information Processing Systems Conference 20 (NIPS'07)*, 2008.
- [22] P. Lamere and D. Eck. Using 3d visualizations to explore and discover music. In *Proceedings of the 8th International Conference on Music Information Retrieval (ISMIR 2007)*, 2007.
- [23] D. Eck. Beat tracking using an autocorrelation phase matrix. In *Proceedings of the 2007 International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, pages 1313–1316. IEEE Signal Processing Society, 2007.
- [24] D. Eck, T. Bertin-Mahieux, and P. Lamere. Autotagging music using supervised machine learning. In *Proceedings of the 8th International Conference on Music Information Retrieval (ISMIR 2007)*, 2007.
- [25] J. Paiement, D. Eck, and S. Bengio. Probabilistic melodic harmonization. In L. Lamontagne and M. Marchand, editors, *Canadian Conference on AI*, volume 4013 of *Lecture Notes in Computer Science*, pages 218–229. Springer, 2006.
- [26] D. Eck. Beat induction using an autocorrelation phase matrix. In M. Baroni, A. R. Addessi, R. Caterina, and M. Costa, editors, *The Proceedings of the 9th International Conference on Music Perception and Cognition (ICMPC9)*, pages 931–932. Causal Productions, 2006.
- [27] J. Bergstra, A. Lacoste, and D. Eck. Predicting genre labels for artists using freedb. In *Proceedings of the 7th International Conference on Music Information Retrieval (ISMIR 2006)*, pages 85–88, 2006.
- [28] J. Paiement, D. Eck, and S. Bengio. A probabilistic model for chord progressions. In *Proceedings of the 6th International Conference on Music Information Retrieval (ISMIR 2005)*, pages 312–319, London: University of London, 2005.

- [29] J. Paiement, D. Eck, S. Bengio, and D. Barber. A graphical model for chord progressions embedded in a psychoacoustic space. In *ICML '05: Proceedings of the 22nd international conference on Machine learning*, pages 641–648, New York, NY, USA, 2005. ACM Press.
- [30] D. Eck and N. Casagrande. Finding meter in music using an autocorrelation phase matrix and shannon entropy. In *Proceedings of the 6th International Conference on Music Information Retrieval (ISMIR 2005)*, pages 504–509, London: University of London, 2005.
- [31] N. Casagrande, D. Eck, and B. Kégl. Frame-level audio feature extraction using AdaBoost. In *Proceedings of the 6th International Conference on Music Information Retrieval (ISMIR 2005)*, pages 345–350, London: University of London, 2005.
- [32] N. Casagrande, D. Eck, and B. Kégl. Geometry in sound: A speech/music audio classifier inspired by an image classifier. In *Proceedings of the International Computer Music Conference (ICMC)*, pages 207–210, 2005.
- [33] A. Graves, D. Eck, N. Beringer, and J. Schmidhuber. Biologically plausible speech recognition with LSTM neural nets. In *Proceedings of the First Int'l Workshop on Biologically Inspired Approaches to Advanced Information Technology (Bio-ADIT)*, pages 127–136, 2004.
- [34] D. Eck. A machine-learning approach to musical sequence induction that uses autocorrelation to bridge long timelags. In S. Lipscomb, R. Ashley, R. Gjerdingen, and P. Webster, editors, *The Proceedings of the Eighth International Conference on Music Perception and Cognition (ICMPC8)*, pages 542–543, Adelaide, 2004. Causal Productions.
- [35] J. Pérez-Ortiz, J. Schmidhuber, F. Gers, and D. Eck. Improving long-term online prediction with Decoupled Extended Kalman Filters. In J. Dorrnsoro, editor, *Artificial Neural Networks – ICANN 2002 (Proceedings)*, pages 1055–1060, Berlin, 2002. Springer.
- [36] F. Gers, J. Pérez-Ortiz, D. Eck, and J. Schmidhuber. Learning context sensitive languages with LSTM trained with Kalman filters. In J. Dorrnsoro, editor, *Artificial Neural Networks – ICANN 2002 (Proceedings)*, pages 655–660, Berlin, 2002. Springer.
- [37] F. Gers, J. Perez-Ortiz, D. Eck, and J. Schmidhuber. DEKF-LSTM. In *Proceedings of the 10th European Symposium on Artificial Neural Networks, ESANN 2002*, 2002.
- [38] D. Eck and J. Schmidhuber. Finding temporal structure in music: Blues improvisation with LSTM recurrent networks. In H. Bourlard, editor, *Neural Networks for Signal Processing XII, Proceedings of the 2002 IEEE Workshop*, pages 747–756, New York, 2002. IEEE.
- [39] D. Eck and J. Schmidhuber. Learning the long-term structure of the blues. In J. Dorrnsoro, editor, *Artificial Neural Networks – ICANN 2002 (Proceedings)*, pages 284–289, Berlin, 2002. Springer.
- [40] F. A. Gers, D. Eck, and J. Schmidhuber. Applying LSTM to time series predictable through time-window approaches. In G. Dorffner, editor, *Artificial Neural Networks – ICANN 2001 (Proceedings)*, pages 669–676, Berlin, 2001. Springer.
- [41] D. Eck. A network of relaxation oscillators that finds downbeats in rhythms. In G. Dorffner, editor, *Artificial Neural Networks – ICANN 2001 (Proceedings)*, pages 1239–1247, Berlin, 2001. Springer.
- [42] D. Eck. Learning simple metrical preferences in a network of Fitzhugh-Nagumo oscillators. In *The Proceedings of the Twenty-First Annual Conference of the Cognitive Science Society*, New Jersey, 1999. Lawrence Erlbaum Associates.
- [43] T. Chemero and D. Eck. An exploration of representational complexity via coupled oscillators. In *Proceedings of the Tenth Midwest Artificial Intelligence and Cognitive Science Society*, Cambridge, Mass., 1999. MIT Press.

[44] M. Gasser and D. Eck. Representing rhythmic patterns in a network of oscillators. In *The Proceedings of the International Conference on Music Perception and Cognition*, number 4, pages 361–366, New Jersey, 1996. Lawrence Erlbaum Associates.

[45] D. Eck and M. Gasser. Perception of simple rhythmic patterns in a network of oscillators. In *The Proceedings of the Eighteenth Annual Conference of the Cognitive Science Society*, New Jersey, 1996. Lawrence Erlbaum Associates.

### Book Chapters

[46] T. Bertin-Mahieux, D. Eck, and M. I. Mandel. Automatic tagging of audio: The state-of-the-art. In W. Wang, editor, *Machine Audition: Principles, Algorithms and Systems*. IGI Publishing, 2010.

[47] H. Jaeger and D. Eck. Can't get you out of my head: A connectionist model of cyclic rehearsal. In *Modeling Communications with Robots and Virtual Humans*, LNCS. Springer-Verlag, 2007.

[48] D. Eck, M. Gasser, and R. Port. Dynamics and embodiment in beat induction. In P. Desain and L. Windsor, editors, *Rhythm Perception and Production*, pages 157–170. Swets and Zeitlinger, Lisse, The Netherlands, 2000.

### Workshops and Contests

[49] B. Kégl, T. Bertin-Mahieux, and D. Eck. Metropolis-Hastings sampling in a FilterBoost music classifier. International Workshop on Machine Learning and Music (ICML/COLT/UAI 2008), Helsinki, Finland, 2008.

[50] L. Pugin, J. Burgoyne, D. Eck, and I. Fujinaga. Book-adaptive and book-dependant models to accelerate digitalization of early music. NIPS 2007 Workshop on Music, Brain and Cognition, 2007.

[51] J. Paiement, Y. Grandvalet, S. Bengio, and D. Eck. A generative model for rhythms. NIPS 2007 Workshop on Music, Brain and Cognition, 2007.

[52] D. Eck. Measuring and modeling musical expression. NIPS 2007 Workshop on Music, Brain and Cognition, 2007.

[53] D. Eck. Generating music sequences with an echo state network. NIPS 2006 Workshop on Echo State Networks and Liquid State Machines, 2006.

[54] D. Eck. Meter and autocorrelation. 10th Rhythm Perception and Production Workshop (RPPW), Alden Biesen, Belgium, 2005.

[55] D. Eck and N. Casagrande. A tempo-extraction algorithm using an autocorrelation phase matrix and shannon entropy. MIREX tempo extraction contest ([www.music-ir.org/evaluation/mirex-results](http://www.music-ir.org/evaluation/mirex-results)), 2005.

[56] A. Lacoste and D. Eck. Onset detection with artificial neural networks. MIREX note onset detection contest, 2005.

[57] J. Bergstra, N. Casagrande, and D. Eck. Genre classification: Timbre- and rhythm-based multiresolution audio classification. MIREX genre classification contest, 2005.

[58] J. Bergstra, N. Casagrande, and D. Eck. Artist recognition: A timbre- and rhythm-based multiresolution approach. MIREX artist recognition contest, 2005.

[59] D. Eck. Bridging long timelags in music. NIPS 2004 Workshop on Music and Machine Learning (MIPS), Whistler, British Columbia, 2004.

[60] D. Eck. Using autocorrelation to bridge long timelags when learning sequences of music. IRIS 2004 Machine Learning Workshop, Ottawa, Canada, 2004.

- [61] D. Eck. Challenges for machine learning in the domain of music. BRAMS Workshop on Brain and Music, Montreal Neurological Institute, 2004.
- [62] D. Eck. Time-warped hierarchical structure in music and speech: A sequence prediction challenge. NIPS 2003 Workshop on Recurrent Neural Networks, Whistler, British Columbia, 2003.
- [63] D. Eck. Real time beat induction with spiking neurons. Music, Motor Control and the Mind: Symposium at Monte Verita, May, 2002.

### **Selected Recent Invited Presentations**

- [64] D. Eck. MIR at google: Strategies for scaling to large music datasets using ranking and auditory sparse-code representations. Future of MIR (fMIR) special session at ISMIR 2010, Utrecht, NL, August, 2010.
- [65] D. Eck. Panelist: Future of MIR industrial panel. Future of MIR (fMIR) special session at ISMIR 2010, Utrecht, NL, August, 2010.
- [66] D. Eck. Machine learning techniques for music recommendation and music discovery. School of Informatics and Computing Colloquium, Bloomington, January, 2010.
- [67] D. Eck. Learning music at multiple timescales. Vanier College, Montreal, September, 2009.
- [68] D. Eck. Applying machine learning to music and motion. Ubisoft Inc., Montreal, January, 2009.
- [69] D. Eck. What can machines learn from music performances? The Canadian Higher Education IT Conference, Montreal, June, 2009.
- [70] D. Eck. An overview of machine learning with applications in music and motion. BRAMS Scientific Day, Montreal, May, 2009.
- [71] D. Eck. Autotagger: an algorithm for automatically tagging music collections using large-scale data mining and supervised machine learning. Departmental Colloquium, DIRO, University of Montreal, Montreal, Canada, May, 2008.
- [72] D. Eck. Measuring and modeling musical expression. CRA Annual Meeting for Computer Science & Computer Engineering Chairs, Snowbird, Utah, July, 2008.
- [73] D. Eck. Panelist. Pop & Policy Music Recommendation Panel, Montreal, Canada, October, 2007.
- [74] D. Eck. Automatically tagging audio files using supervised learning on acoustic features. Google Research Labs, Mountainview Calif, USA, April, 2007.
- [75] D. Eck. An ensemble learning approach to music classification. Sun labs, Sun Microsystems, Boston Mass, USA, April, 2006.
- [76] D. Eck. Learning musical structure. New York University Faculty of Music, New York, USA, March, 2006.
- [77] D. Eck. Using autocorrelation to find tempo and structure in music. Austrian Institute for Artificial Intelligence (OFAI), Vienna, Austria, March, 2005.
- [78] D. Eck. Entropy and autocorrelation: Using simple statistics to find tempo and metrical structure in unfiltered digital audio. CIRMMT, McGill University, Montreal, Canada, March, 2005.
- [79] D. Eck. Methods for discovering metrical structure in music. Research Center for Neuropsychology and Cognition (CERNEC), U. of Montreal, Montreal, Canada, November, 2004.
- [80] D. Eck. LSTM hybrid recurrent networks for music and speech. Oregon Graduate Institute (OGI), Portland, Oregon, USA, March, 2003.

[81] D. Eck. Timeseries analysis with Long Short-Term Memory (LSTM). Los Alamos National Laboratories (LANL), Los Alamos, New Mexico, USA, March, 2003.

[82] D. Eck. Beat induction with spiking neurons. L'Institut de Recherche et Coordination Acoustique/Musique (IRCAM), Paris, France, August, 2002.

### Selected Grants

**NSERC-STPCS.** 222,000\$. Deep learning of similarity spaces for sequential web data. Operating grant, with Yoshua Bengio (PI; Univ. of Montreal) and Pascal Vincent (Univ. of Montreal), 2008 – 2009.

**NSERC Discovery.** 110,000\$. Learning Musical Structure with Machines. Operating grant, individual, 2007.

**CFI New Initiatives.** 14,270,000\$. The Biological Foundations of Music. Infrastructure for BRAMS facilities; with Isabelle Peretz (co-PI; Univ. of Montreal), Robert Zatorre (co-PI; MNI), Stephen McAdams (McGill) and others, 2006.

**CFI New Opportunities.** 710,000\$. A Laboratory for Research In Music Cognition and Performance. Infrastructure; Boesendorfer piano laboratory; individual, 2006.

**NSERC INNOV.** 124,540\$. A New Architecture for Recommending Music to Consumers. Industrial collaboration; with Daniel Levitin (PI; McGill Univ) and Yoshua Bengio (Univ. of Montreal), 2005.

### Honors and Awards

2008	Best Student Paper Award (Manzagol, Bertin-Mahieux & Eck, ISMIR 2008)
2006	University of Siena / University of Montreal Inter-university Visiting Professor Award
2005	1st Place Award, Music Genre Recognition, MIREX MIR Programming Contest at the ISMIR conference, London (Casagrande, Bergstra & Eck)
2005	1st Place Award, Note Onset Detection, MIREX MIR Programming Contest at the ISMIR conference, London (Lacoste & Eck)
2000	Postdoctoral Fellowship Award, Swiss National Science Foundation (IDSIA)
1991	Graduated Honors and Distinction, B.A., Indiana University
1987-1989	DAMR Merit Scholarship, St. Joseph's High School, South Bend, Indiana