# Colin Raffel

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## Education

### Columbia University, New York, NY

PhD in Electrical Engineering at the Laboratory for the Recognition and Organization of Speech and Audio, advisor Dan Ellis, 4.1 cumulative GPA, 2012–2016 (expected)

### Stanford University, Stanford, CA

Master of Arts in Music, Science, and Technology at the Center for Computer Research in Music and Acoustics, 4.1 cumulative GPA, 2009–2010

### Oberlin College, Oberlin, OH

Bachelor of Arts in Mathematics with Physics minor and independent studies in audio circuit design, 3.7 cumulative GPA, 2005–2009

### Relevant Courses Taken

Advanced Machine Learning, Statistical Machine Learning, Introduction to Adaptive Signal Representations, Sparse Representations and High-Dimensional Geometry, Speech Recognition, Signal Processing Methods in Musical Acoustics, Audio Applications of the Fast Fourier Transform

## Publications

Colin Raffel and Daniel P. W. Ellis, **"Pruning Subsequence Search with Attention-Based Embedding"**, in *Proceedings of the 2016 IEEE International Conference on Acoustics, Speech and Signal Processing*, 2016 (to appear).

Colin Raffel and Daniel P. W. Ellis, **"Optimizing DTW-Based Audio-to-MIDI Alignment and Matching"**, in *Proceedings of the 2016 IEEE International Conference on Acoustics, Speech and Signal Processing*, 2016 (to appear).

Nikolai Yakovenko, Liangliang Cao, Colin Raffel, and James Fan, **"Poker-CNN: A Pattern Learning Strategy for Making Draws and Bets in Poker Games"**, in *Proceedings of the 30th AAAI Conference on Artificial Intelligence*, 2016 (to appear).

Colin Raffel and Daniel P. W. Ellis, **"Accelerating Multimodal Sequence Retrieval with Convolutional Networks"**, in *NIPS Multimodal Machine Learning Workshop*, 2015.

Colin Raffel and Daniel P. W. Ellis, **"Large-Scale Content-Based Matching of MIDI and Audio Files"**, in *Proceedings of the 16th International Society for Music Information Retrieval Conference*, 2015.

Brian McFee, Colin Raffel, Dawen Liang, Daniel P. W. Ellis, Matt McVicar, and Oriol Nieto, **"librosa: Audio and Music Signal Analysis in Python"**, in *Proceedings of the 14th Python in Science Conference*, 2015.

Colin Raffel, Brian McFee, Eric J. Humphrey, Justin Salamon, Oriol Nieto, Dawen Liang, and Daniel P. W. Ellis, **"mir_eval: A Transparent Implementation of Common MIR Metrics"**, in *Proceedings of the 15th International Society for Music Information Retrieval Conference*, 2014.

Colin Raffel and Daniel P. W. Ellis, **"Estimating Timing and Channel Distortion Across Related Signals"**, in *Proceedings of the 2014 IEEE International Conference on Acoustics, Speech and Signal Processing*, 2014.

Colin Raffel, **"Using Noise Substitution for Backwards-Compatible Audio Codec Improvement"**, in *Proceedings of the 129th Convention of the Audio Engineering Society*, 2010.

Colin Raffel and Julius O. Smith, **"Practical Modeling of Bucket-Brigade Device Circuits"**, in *Proceedings of the 13th International Conference on Digital Audio Effects (DAFx-10)*, 2010.

Colin Raffel, Nick Kruge, Diane Douglas, Edgar Berdahl, and Wendy Ju, **"The Lattice Harp: A New Hybrid Instrument and Controller"**, in *Proceedings of the 2010 International Computer Music Conference*, 2010.

# Technical Reports, Whitepapers, etc.

Colin Raffel and Daniel P. W. Ellis, **"Feed-Forward Networks with Attention Can Solve Some Long-Term Memory Problems"**, *arXiv:1512.08756 [cs.LG]*, 2015.

Andreas Jansson, Colin Raffel, and Tillman Weyde, **"This Is My Jam: Data Dump"**, *16th International Society for Music Information Retrieval Conference Late Breaking and Demo Papers*, 2015.

Colin Raffel, **"Learning Efficient Representations for Sequence Retrieval"**, *National Science Foundation Data Science Workshop*, 2015.

Colin Raffel and Daniel P. W. Ellis, **"Intuitive Analysis, Creation and Manipulation of MIDI Data with pretty_midi"**, *15th International Society for Music Information Retrieval Conference Late Breaking and Demo Papers*, 2014.

Colin Raffel and Daniel P. W. Ellis, **"Reproducing Pitch Experiments in "Measuring the Evolution of Contemporary Western Popular Music""**, *Technical Report*, 2013.

# Honors and Awards

**Best Student Paper**, 16th International Society for Music Information Retrieval Conference, 2015

**Travel Grant**, National Science Foundation Data Science Workshop, 2015

**Best Poster Presentation**, 15th International Society for Music Information Retrival Conference, 2014

**Student Travel Award**, International Society for Music Information Retrieval, 2014

**Prize for Reproducibility in Audio and Music Research**, SoundSoftware.ac.uk, 2013

**NSF Integrative Graduate Education and Research Traineeship Grant**, 2012–2014

**Ableton Best Hack Award**, Music Hack Day San Francisco, 2012

**Best Educational App: Rock Prodigy**, Appy Awards, 2011

**Echo Nest Best Hack Award**, Music Hack Day Barcelona, 2010

**7Digital Best Hack Award**, Music Hack Day Barcelona, 2010

# Business Ventures

## Experimentalists Anonymous

Design, build, and sell custom electronic devices; host audio circuit schematic archive with over three million downloads served; maintain online message board with over fourteen thousand posts; provide site hosting for do-it-yourself audio hardware enthusiasts; help individuals start successful independent businesses selling electronic audio devices, 2003–present

### Noisette Audio, LLC

Provide consulting services in the field of audio signal processing, analysis, and synthesis; develop software for electronic music composition, 2011–2012

## Teaching

### Teacher's Assistant, Deep Learning for Computer Vision and NLP

Advised students on software and final projects culminating in multiple conference submissions, 2015

### Teacher's Assistant, Music Digital Signal Processing

Evaluated projects, provided assistance, and held office hours for a Master's-level course, 2013–2014

### Electronics

Filled in for a professor on sabbatical and taught a recurring electronics course in the Oberlin College Physics Department, 2009

### Circuit Bending

Taught a course on modifying electronic music circuits and basic electronics as part of the Oberlin Experimental College program; developed a curriculum, lab activities, and lectures, 2006

## Students Supervised

**Rafael Valle**, visiting researcher at Columbia Univeristy, 2015

**Hilary Mogul**, undergraduate student at Columbia University, 2014

**Dylan Kario**, undergraduate student at Columbia University, 2014

**Zhengshan Shi**, visiting researcher at Columbia University, 2013

## Talks

**Accelerating Large-Scale Sequence Retrieval with Convolutional Networks** at *IIT Bombay Electrical Engineering Seminar*, 2015.

**Large-Scale Content-Based Matching of MIDI and Audio Files** at *16th International Society for Music Information Retrieval Conference*, 2015.

**Learning Efficient Representations for Sequence Retrieval** at *Boston Data Festival*, 2015.

**Using Convolutional Networks (with Attention) for Orders-of-Magnitude Speedup of DTW-Based Sequence Retrieval** at *Spotify Machine Learning Seminar*, 2015.

**Recurrent Networks in Lasagne** at *Mount Sinai Hammer Lab Seminar*, 2015.

**Lasagne Tutorial** at *Next.ml Boston*, 2015.

**Theano Tutorial** at *Next.ml Boston*, 2015.

**mir_eval** at *Objective Evaluation in Semantic Audio Analysis and Processing Panel at the 138th Convention of the Audio Engineering Society*, 2015.

**MIR at LabROSA in 2014** at *NEMISIG 2015*, 2015.

**Large-Scale Content-Based Matching of Audio and MIDI Data** at *Stanford University DSP Seminar*, 2015.

**Advances and Challenges in Large-Scale Music Information Retrieval** at *Digital Music Research Network+8*, 2013.

**Quantifying Rhythmic Synchrony** at *Midwestern Music Cognition Symposium*, 2013.

**A Sequential Approach to Musical Event Detection** at *Carnegie Mellon University Music and Technology Seminar*, 2011.

**Using Noise Substitution for Backwards-Compatible Audio Codec Improvement** at *129th Convention of the Audio Engineering Society*, 2010.

**ROW-mp3: An Enhanced MP3-Compatible Audio Codec** at *Stanford University DSP Seminar*, 2010.

**Practical Modeling of Bucket-Brigade Device Circuits** at *13th International Conference on Digital Audio Effects*, 2010.

**The Lattice Harp: A New Hybrid Instrument and Controller** at *2010 International Computer Music Conference*, 2010.

**An Effective Model of Bucket-Brigade Device-Based Audio Circuits** at *Stanford University DSP Seminar*, 2010.

**Voltage-Controlled Resistance: Modulate Anything** at *Circuitastrophe Circuit Bending Music Festival*, 2008.

# Poster Presentations

**Accelerating Multimodal Sequence Retrieval with Convolutional Networks** at *NIPS Multimodal Machine Learning Workshop*, 2015.

**Learning Efficient Representations for Sequence Retrieval** at *National Science Foundation Data Science Workshop*, 2015.

**Intuitive Analysis, Creation and Manipulation of MIDI Data with pretty_midi** at *15th International Society for Music Information Retrieval Conference Late Breaking and Demo Papers*, 2014.

**mir_eval: A Transparent Implementation of Common MIR Metrics** at *15th International Society for Music Information Retrieval Conference*, 2014.

**Estimating Timing and Channel Distortion Across Related Signals** at *IEEE International Conference on Acoustics, Speech and Signal Processing*, 2014.

# Employment

## The Way of H

Developed pitch detection and audio timescale modification algorithms for Rock Prodigy, an educational iPhone application for guitarists, 2011–2013

## Beat Kangz Electronics

Maintained and improved audio processing functionality for a hardware- and software-based music production system, 2011–2012

## Imagine Research

Helped develop a machine learning-based sound classification and identification system, 2010–2012

## SacredAgent

Created a musical event detection system which algorithmically demarcates beats and changes in instrumentation, dynamics, and melody, 2010

## WOBC, Oberlin College Radio

Worked as Engineer, 2007–2008, Station Manager, 2008–2009, and Web Administrator, 2009,

### eBay
Employed as summer intern in user interface design department and Musical Instrument category management team, 2004

## Academic Service

### Columbia Neural Network Research Group and Seminar Series
Organize and present paper discussions, tutorials, and seminars on neural networks, 2014–present

### Crucial Python
Organized a seminar series on obscure but useful aspects of the Python programming language, 2014

### Hacking Audio and Music Research (HAMR)
Started a series of hackathons where researchers rapidly prototype new ideas over the course of a weekend; past HAMRs have been held at Columbia University, Dartmouth College, Drexel University, and Academia Sinica, 2013–present

### Intern Supervisor
Oversee summer interns working on Music Information Retrieval research projects, 2013–present

### KZSU, Stanford University Radio
Developed web applications and a music fingerprinting system, 2009–2010

### Mathematics Tutor
Assisted students studying algebra and linear algebra, 2008–2009

### Engineering People of Oberlin Club
Served as the Electrical Engineering group coordinator and web administrator, 2008–2009

### Oberlin Student Cooperative Association Website Coordinator
Maintained the website for Oberlin's eating and living cooperative organization, 2006–2007

## Reviewing

**16th International Society for Music Information Retrieval Conference**, 2015

**EURASIP Journal on Audio, Speech, and Music Processing**, 2015

**15th International Society for Music Information Retrieval Conference**, 2014

**IEEE International Symposium on Information Theory**, 2014

## Additional Coursework

### Music Information Retrieval Workshop, Stanford, CA
Summer workshop covering machine learning and audio feature extraction, 2010

### Rochester Community and Technical College, Rochester, MN
Courses in studio recording and electronic music composition, 2002–2004

## Software Libraries

`mir_eval`, a simple-to-use reference implementation of many music information retrieval metrics.

`lasagne`, a library for constructing neural networks in Theano.

`pretty_midi`, utility classes and functions for easily creating, manipulating, and analyzing MIDI data.

`librosa`, DSP routines for audio and music signal analysis.