

Matthew K. Prockup

CONTACT INFORMATION

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RESEARCH INTERESTS

Modeling musical attributes: When searching, sorting, and recommending music, humans apply a variety of attributes for similarity and discrimination. By designing audio features that capture these attributes, we can develop models that allow us to automatically generate descriptions of music that are grounded and intuitive.

Expression in music performance: Expression is the creative variation a human imparts on a piece of music to make it their own. In combining signal processing techniques, machine learning algorithms, and music performance practices, we attempt to quantify what makes a musical performance expressive and creative.

Interactive live performance systems: A large subset of musical performance requires a relationship between the performer and their audience. By creating interactive media technologies for musical performance, musicians can better communicate contextually relevant information and create more intimate relationships with their audiences.

Developing interactive music and sound-based activities: Through the lens of music technology that we use every day, we can motivate and illustrate science, technology, engineering, arts, and math (STEAM) concepts in K-12 curricula.

EDUCATION

Drexel University, Philadelphia, Pennsylvania USA

Ph.D. Candidate, Electrical Engineering, (expected graduation date: March 2016)

- Dissertation Topic: "Content Based Analysis of Rhythm in Music"
- Advisor: Youngmoo E. Kim

Combined B.S./M.S., Electrical Engineering, June, 2011

- Minor in Music Theory/Composition
- GPA: 3.41/4.00

HONORS AND AWARDS

CMMR 2012 Conference Best Student Paper Award

Eta Kappa Nu (HKN) electrical & computer engineering honor society

Second Place in the 2010 College of Engineering senior design competition

Best Poster Award at Drexel Research Day in 2008 and 2009

Keith Alyea Creative Experience Award for Combining Engineering and Performing Arts

INDUSTRY EXPERIENCE

Pandora Media Inc., Oakland, California USA

Contract Scientist

Fall 2014 - present

I am continuing work from the internship and expanding beyond rhythmic attributes to other elements of the Music Genome Project including instrumentation, sonority, and genre. I created a new

framework for a complete, at scale, pipeline of audio feature extraction, musical attribute model training, and new example prediction for all attributes.

Scientist Intern

Summer 2014

I developed a set of rhythmic audio features and trained models for the rhythm related attributes from Pandora's Music Genome Project. The features and models were computed and evaluated at scale across 1.2 Million audio examples. This work led to three publications at leading conferences in the fields machine learning and music audio signal processing.

ACADEMIC
EXPERIENCE

Drexel University, Philadelphia, Pennsylvania USA

Research Assistant

Fall 2009 - present

Includes current dissertation research, Ph.D. and Masters level coursework and research at Drexel University.

Drexel AppLab Manager

Fall 2013 - present

Manage the day to day operations of a resource center for mobile application development. The AppLab at the Expressive and Creative Interaction Technologies Center (ExCITE) provides an educational resource for Drexel students interested in app development.

Teaching Assistant

Fall 2011 - Spring 2013

Collaborated with instructors to develop content for courses in electrical and computer engineering. Responsibilities include grading homework and exams, as well as leading students through a variety of short term and long term individual projects.

- Freshman Design
- ECE in the Real World
- Intro to Entertainment Engineering

Student Lecturer - Summer Music Technology

Summer 2008 - present

Designed and taught lessons that motivated science, technology, engineering and math (STEM) concepts through musical instrument acoustics, music interfacing, and music information retrieval.

Senior Design

Fall 2009 - Spring 2010

Developed a system that guides a listener through orchestral performances in real-time by presenting contextually relevant annotations in a manner similar to that of a personal museum guide. Acoustic features of a live performance are aligned with features of a time-stamped recording. The aligned position is transmitted to an application on users' mobile devices, which present the annotations using an intuitive and unobtrusive interface.

Multi-touch API Research Co-op

Spring - Summer 2009

Worked with multiple projects including the development and implementation of software interfaces for a multi-touch display. An API was created that allowed developers to incorporate multi-touch gestures into Adobe Flash applications.

Medical Multi-touch Research Co-op

Spring - Summer 2008

Through a joint project with Drexel University, The Hospital at the University of Pennsylvania (HUP), and The Children's Hospital of Philadelphia (CHOP), a custom multi-touch display was constructed and an accompanying software suite was developed to navigate extremely high-resolution pathology biopsy images.

PROJECTS

LiveNote Orchestral Performance Companion

I am continuing further development on the LiveNote Project in collaboration with the Philadelphia Orchestra. We have developed a system that helps users by guiding them through the performance

using a mobile application (iOS/Android app) in real-time. Using audio features, we attempt to align the live performance audio with that of a previously annotated reference recording. The aligned position is transmitted to users' hand-held devices and pre-annotated information about the piece is displayed synchronously.

<http://livenote.philorch.org>

<https://www.youtube.com/watch?v=5qr4xTje6RA>

<https://www.youtube.com/watch?v=QzDW7Pvp81w>

The Science of Jazz

This unique performance allows attendees to experience the science behind the music, augmented with large-screen visuals and an interactive iPhone application illustrating the principles of frequency, harmony, and acoustics. In 2012 and 2013, keyboardist Marc Cary performed with his Focus Trio along with featured soloist and Grammy-Award winning percussionist Will Calhoun and other special guests.

<https://www.youtube.com/watch?v=zJcUX3wmElk>

Remix Interactive

Worked with a class of high school students in 2014 and 2015 as a mentor to develop interactive mobile and web applications to accompany live music performances.

<http://remixinteractive.tumblr.com>

<https://www.youtube.com/watch?v=mi80oZVUSw8>

Come Together, The Hubos

Four of Drexel's HUBO robots perform the Beatles' "Come Together." The HUBOs movements were directed by software in order to perform the gestures necessary to produce the appropriate notes and beats as dictated by a musical score. I created the musical arrangement for drum kit and three "Hubophones," novel percussion instruments I designed and constructed for specifically for this performance.

https://www.youtube.com/watch?v=UMQLX-aw_dc

ACTIVITIES

Percussionist and Musician

I have studied and performed music since childhood. Throughout high school and college, I trained and gained performance experience as a drummer and classical concert percussionist, learned to play piano, and started to compose. I try to find a way to perform and create music every day.

Instructor/Arranger/Composer, Central Bucks SD and Others

Spring 2006 - present

I worked with the Central Bucks South High School music program as a contract educator and composer for the band, orchestra and percussion ensemble. During the 2011, 2012, and 2013 seasons, the group medaled and was additionally presented with the *Best Percussion* award at their circuit's national championship competition. Current and previous ensembles I've worked with include Drexel University, the Central Bucks School District, the East Penn School District, and the Wilson Area School District.

Marching Member, Reading Buccaneers Drum and Bugle Corps

Winter 2003 - Fall 2009

Performed as both a concert percussionist and a marching snare drummer over the span of 6 competitive seasons. Additionally, while a member, the corps went undefeated and won the circuit's world championship five times straight from 2005 through 2009.

COMPUTER SKILLS

Programming Languages (Strong)

C, C++, Objective C (Mac OSX, iOS), Swift (Mac OSX, iOS), Java, Python, Matlab

Programming Languages (Moderate)

PHP, SQL, HiveQL, HTML

Software Production

Xcode, IntelliJ (and derivatives), GIT, Perforce, iPython Notebook

Multimedia Production

PureData, iMovie, Audacity, GarageBand, Logic Studio, Protools, Finale, Sibelius

Productivity

L^AT_EX, Apple iWork Suite, Microsoft Office Suite, Adobe Photoshop and Illustrator

Operating Systems

Mac OSX, iOS, Windows, Linux (Ubuntu)

PUBLICATIONS

Prockup, M., Ehmann, A., Gouyon, F., Schmidt, E., Celma, O., Kim, Y. (2015), “Modeling Genre with the Music Genome Project: Comparing Human-Labeled Attributes and Audio Features.” International Society for Music Information Retrieval Conference, Malaga, Spain, 2015.

Prockup, M., Asman, A., Ehmann, A., Gouyon, F., Schmidt, E., Kim, Y. (2015), “Modeling Rhythm Using Tree Ensembles and the Music Genome Project.” Machine Learning for Music Discovery Workshop at the 32nd International Conference on Machine Learning, Lille, France, 2015.

Prockup, M., Ehmann, A., Gouyon, F., Schmidt, E., Kim, Y. (2015), “Modeling Rhythm at Scale with the Music Genome Project”. IEEE Workshop on Applications of Signal Processing to Audio and Acoustics, New Paltz, New York, 2015.

Prockup, M., Scott, J., and Kim, Y (2014). “Representing Musical Patterns via the Rhythmic Style Histogram Feature.” Proceedings of the ACM International Conference on Multimedia, Orlando, Florida, 2014.

Prockup, M., Schmidt, E. M., Scott, J. and Kim, Y. E. (2013). “Toward Understanding Expressive Percussion Through Content Based Analysis.” Proceedings of the 14th International Society for Music Information Retrieval Conference. Curitiba, Brazil.

Schmidt, E. M., Prockup, M., Scott, J., Dolhansky, B., Morton, B. G., and Kim, Y. E. (2013). “Analyzing the Perceptual Saliency of Audio Features for Musical Emotion Recognition.” Computer Music Modeling and Retrieval. Music and Emotions.

Prockup, M., Grunberg, D., Hrybyk, A., Kim, Y.E., (2013) “Orchestral Performance Companion: Using Real-Time Audio to Score Alignment.” IEEE MultiMedia , vol.20, no.2, pp.52,60, April-June 2013

Schmidt, E. M., Prockup, M., Scott, J., Dolhansky, B., Morton, B. G. and Kim, Y. E. (2012). “Relating Perceptual and Feature Space Invariances in Music Emotion Recognition.” Proceedings of the International Symposium on Computer Music Modeling and Retrieval, London, U.K.: CMMR. (*Best Student Paper Award*)

Scott, J., Schmidt, E. M., Prockup, M., Morton, B. G. and Kim, Y. E. (2012). “Predicting Time-Varying Musical Emotion Distributions from Multi-track Audio.” Proceedings of the International Symposium on Computer Music Modeling and Retrieval, London, U.K.: CMMR.

Batula, A. M., Morton, B. G., Migneco, R., Prockup, M., Schmidt, E. M., Grunberg, D. K., Kim, Y. E., and Fontecchio, A. K. (2012). “Music Technology as an Introduction to STEM.” Proceedings of the 2012 ASEE Annual Conference, San Antonio, Texas: ASEE.

Scott, J., Dolhansky, B., Prockup, M., McPherson, A., Kim, Y. E. (2012). “New Physical and

Digital Interfaces for Music Creation and Expression.” Proceedings of the 2012 Music, Mind and Invention Workshop, Ewing, NJ

Prockup, M., Batula, A. M., Morton, B. G., Kim, Y. E. (2012). “Education Through Music Technology.” Proceedings of the 2012 Music, Mind and Invention Workshop, Ewing, NJ

Scott, J., Prockup, M., Schmidt, E. M., Kim, Y. E. (2011). “Automatic Multi-Track Mixing Using Linear Dynamical Systems.” Proceedings of the 8th Sound and Music Computing Conference, Padova, Italy: SMC.

Kim, Y. E., Batula, A. M., Migneco, R., Richardson, P., Dolhansky, B., Grunberg, D., Morton, B. G., Prockup, M., Schmidt, E. M., and Scott, J. (2011). “Teaching STEM Concepts Through Music Technology and DSP.” Proceedings of the 14th IEEE Digital Signal Processing Workshop and 6th IEEE Signal Processing Education Workshop, Sedona, AZ: DSP/SPE.

COURSE WORK

Engineering Undergraduate

Calculus I, II	Electronic Devices
Multi-variable Calculus	Electrical Engineering Lab I, II, III, IV
Vector Calculus	Programming for Engineers (Java)
Linear Eng. Systems (Linear Algebra)	Adv. Programming for Engineers (Java)
Dynamic Eng. Systems (Diff. Equations)	Circuits
Chemistry I, II	Transform Methods
Physics I, II, III	E&M Fields and Waves
Biology	Intro to DSP
Introduction to Thermodynamics	Deterministic Signal Processing
Evaluation & Presentation of Data I, II	Statistical Signal Processing
Digital Logic Design	

Music Undergraduate

Applied Music (private lessons): Piano	Ear Training
Applied Music (private lessons): Percussion	Modern Arranging Techniques
Introduction to Music	Music Composition
World Musics	Digital Music Composition
Music Theory I, II	

Engineering Graduate

Probability and Random Variables	Cognition and Multitasking
Random Processes and Spectral Analysis	Compressive Sensing
Detection and Estimation Theory	Computer Networks (Java, C++)
Deterministic DSP	DSP for Sound and Hearing
Fundamentals of Computer Vision	Speech Processing
Developing User Interfaces	Image Processing
Computational Archeology	Machine Learning
Programming Tools and Environments	Machine Listening and Music-IR