Leigh M. Smith, B.App.Sci, P.G.Dip (Comp.Sci.), Ph.D

149 Avenue C, Apt 1R, New York, NY 10009, USA +1 (646) 250-1134
leigh@leighsmith.com, http://www.leighsmith.com, LinkedIn

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Work Experience

leighsmith.com Inc., New York, NY, USA **March 2014 to Present**

Owner, Contract Software Engineer (Technologies listed below)

- Consultant to a number of clients in the audio, music and general software industries, providing practical commercial experience in machine learning, R&D and software development.

Humtap Inc., San Francisco, CA, USA, working remotely **May 2014 to Present**

Contract Software Engineer and Project Manager (Amazon Web Services EC2 Ubuntu Linux, Windows Server 2012: Python, PostgreSQL, Tornado, boto, Essentia, vagrant, nginx, redis)

- Development of beat tracking and vocal transcription methods for mobile app for untrained musical collaboration and composition (http://www.humtap.com).
- Managed combined development and content team across three offices (SF, NYC, Berlin) using two week sprint based Agile/Scrum methods using JIRA, Confluence, Bitbucket tools. Responsible for product road map specification, developer recruitment, organisation structure.
- Development of an AWS S3 based content management system for audio assets in Python using SQLAlchemy to enable music information retrieval algorithm operation and evaluation with a location transparent API.

Music Prodigy Inc., Los Angeles, CA, USA, working remotely **March 2014 to April 2014**

Contract Software Engineer (iOS, MacOS X, Rackspace.com Ubuntu Linux: Objective C++, LAMP, Xcode, Flurry SDK, Facebook iOS SDK and ads API, cocos2d SDK)

- Upgrade of audio signal processing routines for iOS guitar tutor app RockProdigy (http://rockprodigy.com), performing real-time polyphonic pitch transcription. Implemented real-time audio compressor and reverb algorithms. Implementation of iTunes In-App Purchases, Facebook mobile SDK analytics. Code and data migration from legacy MS SQL server/ASP C# web app to LAMP stack.

iZotope Inc., Cambridge, MA, USA, working remotely **February 2012 to February 2014**

Lead Engineer (AWS EC2 Ubuntu Linux, MacOS X, Win7: Python, LAMP, Octave, Java, C++, Javascript, Boto, git, W3C XML Schema, XSLT, JIRA, MacOS X Xcode, Windows VS2012)

- Lead developer of Agile/Scrum + Kanban team (using JIRA/Greenhopper) bringing to market MediaMined Discover (http://mediamined.izotope.com/), a REST based, SOA web service for rhythmic and timbral similarity (content based search) of musical loop libraries. Utilized and implemented PCA, LDA, locality sensitive hashing and multiple distance algorithms. Built on AWS Elastic Beanstalk, EC2 with Cloudwatch process monitoring, RDS, SWF for cloud based signal processing control, SNS for automated testing. Implemented cross platform C++, Python and shell script client side APIs for MediaMined.
- Evaluation and outreach to academic community describing the MediaMined Listen audio classification system [21, 6].

- Designed and ran web based listener judgement task experiments to quantify A/B performance of similarity algorithms.

CCRMA, Stanford University, Palo Alto, CA, USA **June 2011 to Present**

Workshop Lecturer and Instructor (Matlab, Python, iPython notebooks, Essentia, librosa SDKs)

- Responsible for co-teaching the week-long summer workshop in Music Information Retrieval at Stanford University's Center for Computer Research in Music and Acoustics (CCRMA). Lectured in content based feature extraction, beat tracking and tempo estimation, machine learning and information retrieval evaluation techniques. Preparation of iPython notebooks and Matlab code examples for labs and tutorials.

Imagine Research, San Francisco, CA, USA, working remotely **October 2010 to February 2012**

Lead Software Architect (MacOS X, AWS EC2 Ubuntu Linux: gcc C++, Xcode, LAMP, Javascript, CSS, Java, Weka, Python, svn)

- Development of command line and GUI based music information retrieval tools using audio feature extraction and SVM machine learning for MacOS X/Windows 7 and AWS web deployment platforms. NSF SBIR II funded company Imagine Research was wholly acquired by iZotope Inc. February 2012.

Poptank Studios Inc., Los Angeles, CA, USA, working remotely **June 2010 to October 2010**

Lead Audio Engineer (Windows XP, 7, MacOS X: MS Visual C++/gcc Objective-C GNUstep/MinGW, Miles Audio, portaudio, mercurial, FogBugz.com)

- Software development in multi-threaded low latency audio signal processing for real time games. Intel SSE2 vector based DSP for pitch detection.

IRCAM, Paris, France **October 2008 to April 2010**

Charge de Recherche et Development (MacOS X, Linux: Matlab, C++, Common Lisp, DOM, XSLT, W3C XML schema)

- Research in computational models of rhythm for music information retrieval as part of the Quaero project in multimedia search and retrieval. Research in models of downbeat determination, evaluation methods of expectancy [13], beat tracking error detection [14], and rhythmic similarity [15]. Developed XML schemas for MIR annotation and evaluation between Quaero partners (http://www.ircam.fr/anasyn/smith).

- External examiner of M.Sc. thesis of Ronan Kelly [4].

Universiteit van Amsterdam, The Netherlands **November 2005 to October 2008**

Postdoctoral Researcher (MacOS X: Common Lisp/Objective-C; CLOS, Cocoa, Matlab/Octave)

- Research in models of musical rhythm perception as part of the Music Cognition Group at the Institute for Logic, Language and Computation. Collaborated between research institutes on the EU FP6 Project "Emergent Cognition through Active Perception" project. Designed and evaluated models of syncopation and complexity [16], and rhythmic expectancy [18] using multiresolution decomposition [19, 3, 17].

- Supervision of B.Sc. (Artificial Intelligence) projects, examination of M.Sc. thesis of Michiel Emile Baneke [1]. Lectured on Music and Probability, UvA. Lectured on Multiresolution Representations of Musical Rhythm and Expectation, Utrecht University.

Thumtronics Ltd., Busselton, Australia **May 2005 to November 2005**

Lead Software Engineer (Win32, Linux, MacOS X: Objective-C/C/C++; GNUstep, Cocoa, USB API)

- Cross platform, embedded systems application development of the "Thummer" USB expressive musical controller [5].

Oz Music Code LLC., New York, U.S.A **November 2002 to April 2005**

Chief Technical Officer (MacOS X, Win32, Linux: Objective-C/C/C++; Cocoa; Xcode; GNUstep; Altivec vector processing; Audio Unit API; Octave/Matlab; CVS, Subversion; MP3 codec)

- Designed and developed "Alphabet Soup" — a low latency keyboard based sample and MP3 player/editor/signal processor consumer application.
- Developed "Seeker440" — an accurate realtime pitch detector Audio Unit plugin for instrument tuning.

Duggal Interactive & Tronic Studio, curated by Sebastien Agnessens, New York, U.S.A **November 2002**

Contract Software Engineer (MacOS X: Octave/Matlab; Objective-C/C; QuickTime Effects API)

- Developed "The Retail Experiment" (http://www.leighsmith.com/image/tid/3) — A real-time video installation at Diesel Denim Gallery, SoHo, New York. Luminance mask and faded captured still images into a prepared video stream using no external video processing hardware.

tomandandy Music Inc, New York, U.S.A **March 1999 to September 2002**

Software Designer, Project Manager and Lead Developer (MacOS X, Windows 2000, Linux: Objective-C/C++/C; Smalltalk; Python; Cocoa/GNUstep/CoreAudio/CoreMIDI/PortAudio APIs; Project Builder/Interface Builder IDE; Win32: Visual C++, DirectMusic, DirectSound APIs; CVS)

- Responsible for recruitment, training and management of five programmers. Responsible for liaison with technical and management staff at Apple Computer, M-Audio Inc. and open-source developers.
- Designer and lead developer of "Ennio" — a consumer application for automatically composing sound tracks to video, or video clips to music using automated analysis of video images extracting edits, motion and image tracking, and matching these against audio beats and phrases extracted from signal processing analysis of MP3 encoded music.
- Lead developer for the open-source MusicKit/SndKit (http://www.musickit.org) — cross-platform music representation and synthesis project in Objective-C [2].
- Member of a development team writing "The Brain" — a music composition system.
- Developed CoreMIDI drivers for M-Audio (http://www.m-audio.com) for their MIDISPORT USB MIDI interface devices.
- System administration of HTTP, NFS filesystem, CVS version control, FAQ and QuickTime streaming serving using MacOS X-Server and RedHat Linux, SonicWall firewalling/VPN configuration.

Part Time Employment During Ph.D Studies

tomandandy Music Inc, New York, U.S.A **December 1998 to January 1999**

Contract Software Engineer (MacOS X Server: Mach kernel, C/Objective-C)

- Ported the NeXTStep Mach MIDI Driver (in C) from NeXT/Intel architectures to MacOS X-Server (developer pre-releases) running on Intel and PowerPC architectures.

University of Western Australia, Perth, Australia **August 1994 to December 1998**

Research Programmer, Tutor, System Administrator (Solaris/SunOS, Linux, Windows 95/NT, MacOS: Microsoft C; SAS; Java; samba; amanda; sendmail; HTML)

- Lectured in artificial neural network architectures and applications. Tutored in fundamental and advanced algorithms, concurrent programming techniques and analysis. Demonstrated in Java application and applet programming. Trained other system administrators on the administration of the Computer Science network.

- Software maintenance and programming in Microsoft C for vision research in saccadic eye movements. Design and coding of an ECG wave measuring system in Microsoft C using a graphical digitiser and audio and visual feedback for rapid operator performance. Ad-hoc statistic queries and reports in the SAS statistical programming language for road accident research.

- System administration of UWA's Computer Science Department and Psychology Department vision laboratory networks using NFS and samba server applications with Linux, MacOS, Windows 3.11–NT clients. Backup system design and implementation (amanda), sendmail script programming.

Full Time Employment After B.AppSc.

Comsys International Pty Ltd, Perth, Australia **June to August 1992**

Contract Software Engineer (SunOS 4: ANSI C)

- Member of development team of a real time fiber optic cable monitoring and maintenance system.

GS Corporation Pty Ltd, Perth, Australia **December 1990 to June 1992**

Contract Software Designer and Engineer (MS-DOS: Microsoft ANSI C; Solaris: POSIX, C, BSD socket library)

- Design and implementation of a custom aerial photography positioning system for the Western Australian state government department of lands adminstration (DOLA) interpolating shutter release times with GPS position. Conversion of graphics and peripherals drivers of a Geographic/Land Information System to device independent C graphics library.

Jill Smith for Bristile Pty Ltd, Perth, Australia **October 1990**

Technical Support (Irix)

- Customer support and system administration for a graphic artist using a Personal IRIS graphic design package.

Gosh Leather Pty Ltd, Perth, Australia **September 1990**

Contract Software Designer and Engineer (MS-DOS: SNOBOL4)

- Development of an accounting report conversion software. Consulted on the networking interconnection of Macintosh and PC systems.

Intellect Australia Pty Ltd, Perth, Australia **March 1988 to September 1990**

System Designer, Software Engineer (Xenix, MS-DOS: Microsoft, Borland ANSI C; IAR, Introl C cross-compilers; 8051 and 68HC11 assembly language)

- Designed and implemented a proprietary macro assembler and loader, RSA encryption algorithms, embedded system communications, hardware diagnostics and drivers for electronic funds transfer hardware and MS-DOS PCs.

Education

Doctor of Philosophy, Computer Science (Part Time) **1993–1999**

University of Western Australia, Crawley, Western Australia (http://www.csse.uwa.edu.au)

Thesis: *A Multiresolution Time-Frequency Analysis and Interpretation of Musical Rhythm* [12]

Researching the application of continuous wavelet transforms for time-frequency representations, to emergent musical rhythm perception by computer [10, 20, 9, 11].

Postgraduate Diploma in Computing Science (Part time) **1990–1991**

Curtin University of Technology, Bentley, Western Australia (http://www.cs.curtin.edu.au)

Thesis: *Surveys for Design Criteria of Interactive Computer Music Performance Systems* [8]

Bachelor of Applied Science (Multidisciplinary Science) **1985–1988**

Curtin University of Technology, Bentley, Western Australia (http://www.cs.curtin.edu.au)

Major: Computer Science.

Minor: Electronic Engineering.

Thesis: *Development of Raytrace Stage 3: Textures* [7]

Creative Experience

- Tape composition "Notions of Location" accepted and performed at ICMC-96, Hong Kong, reviewed Array 16(3) p21.
- Co-recipient with Mark Cain of a 1996 ANAT research and development grant for expanding performance gestures on saxophone and guitar using 6-DOF motion tracking devices (Western Australia).
- Collaborated with PICA artist-in-residence Chris Mann, constructing a real time voice performance system using digital audio samplers and a virtual reality hand motion sensing "Powerglove" for Australian Broadcasting Commission filming/recording, June 1992 (W.A).
- Classical guitar studies with Eddie Roberts, John Jooste and Peter Altmeier-Mort (W.A). Arabic 'ud (fretless lute) studies with George Ziadeh (Brooklyn, NY). Participated in 2013 NY Jazz guitar workshop with Kenny Wessel and Vic Juris.
- Poetry recordings for electroacoustic compositions and videos for composers Roque Rivas and Marco Stroppa (Paris 2009).
- Guitarist with vocals/organ/guitar jazz trio "The Pleasure Programmes".
- Mastered audio CD for classical composer Howard Elmer (New York, NY).
- Experimental soundtrack production for a 20 min documentary by TAFE student Gwen Sputore (W.A).
- Completed FTI "Introduction to Video Production" Course 1992 covering S-VHS video camerawork and editing. Completed two short video productions, including sound track co-compositions (W.A).

Referees

- Dr. Geoffroy Peeters (Quaero Music Project Leader, IRCAM) Geoffroy.Peeters@ircam.fr
- Dr. Henkjan Honing (Project Leader Music Cognition Group, University of Amsterdam) honing@uva.nl
- Prof. Sue Denham (Project Leader EmCAP, University of Plymouth) S.Denham@plymouth.ac.uk
- Prof. Robyn Owens (Former Head of School of Computer Science, now Dean of Postgraduate Research, University of Western Australia) robyn@csse.uwa.edu.au
- Dr. Peter Kovesi (Doctoral Supervisor, University of Western Australia) pk@csse.uwa.edu.au
- Prof. Roger Dannenberg (Ph.D Examiner, Department of Computer Science and Electrical Engineering, Carnegie Mellon University) rbd@cs.cmu.edu
- Andy Milburn (Former CEO of tomandandy) andymilburn@mac.com

Select Publications

[1] M. E. Baneke. Music genre analysis for algorithmic composition. Master's thesis, Universiteit van Amsterdam, August 2007.

[2] S. Brandon and L. M. Smith. Next steps from NeXTSTEP: MusicKit and SoundKit in a new world. In *Proceedings of the 2000 International Computer Music Conference*, pages 503–6, Berlin, 2000. International Computer Music Association.

[3] M. Coath, S. Denham, L. M. Smith, H. Honing, A. Hazan, P. Holonowicz, and H. Purwins. Model cortical responses for the detection of perceptual onsets and beat tracking in singing. *Connection Science*, 21(2):193—205, 2009.

[4] R. Kelly. Automatic transcription of polyphonic music using a note masking technique. Master's thesis, University of Limerick, Limerick, Ireland, November 2009.

[5] A. Milne, W. A. Sethares, and J. Plamondon. Isomorphic controllers and dynamic tuning: Invariant fingering over a tuning continuum. *Computer Music Journal*, 31(4):15–32, 2007.

[6] R. S. Schaefer, S. Furuya, L. M. Smith, B. B. Kaneshiro, and P. Toiviainen. Probing neural mechanisms of music perception, cognition, and performance using multivariate decoding. *Psychomusicology: Music, Mind and Brain*, 22(2):168–174, 2012.

[7] L. M. Smith. Development of Raytrace stage 3: Textures. Technical report, School of Mathematics and Computing, Curtin University of Technology, Bentley, Western Australia, 1987.

[8] L. M. Smith. Surveys for design criteria of interactive computer music performance systems. Post graduate diploma in computing science thesis, School of Computing Science, Curtin University of Technology, Bentley, Western Australia, 1991.

[9] L. M. Smith. Listening to musical rhythms with progressive wavelets. In *Proceedings of Tencon '96: Digital Signal Processing Applications*, volume 2, pages 508–13. IEEE, 1996.

[10] L. M. Smith. Modelling rhythm perception by continuous time-frequency analysis. In *Proceedings of the International Computer Music Conference*, pages 392–5. International Computer Music Association, 1996.

[11] L. M. Smith. Compmuse: A perspective West. *Chroma*, 23:2–3, June 1998.

[12] L. M. Smith. *A Multiresolution Time-Frequency Analysis and Interpretation of Musical Rhythm*. PhD thesis, Department of Computer Science, University of Western Australia, July 1999.

[13] L. M. Smith. Evaluation of a multiresolution model of musical rhythm expectancy on expressive performances. In *Proceedings of the 12th Rhythm Production and Perception Workshop (RPPW)*, Lille, France, 2009. (abstract).

[14] L. M. Smith. Beat Critic: Beat tracking octave error identification by metrical profile analysis. In *Proceedings of the International Symposium on Music Information Retrieval*, pages 99–104. Utrecht, Netherlands, 2010.

[15] L. M. Smith. Rhythmic similarity using metrical profile matching. In *Proceedings of the International Computer Music Conference*, pages 177–182, New York, July 2010. International Computer Music Association, Stony Brook University.

[16] L. M. Smith and H. Honing. Evaluating and extending computational models of rhythmic syncopation in music. In *Proceedings of the International Computer Music Conference*, pages 688–91. International Computer Music Association, 2006.

[17] L. M. Smith and H. Honing. Evaluation of multiresolution representations of musical rhythm. In E. Schubert, K. Buckley, R. Eliott, B. Koboroff, J. Chen, and C. Stevens, editors, *Proceedings of the International Conference on Music Communication Science*, Sydney, Australia, 2007. Published online as http://marcs.uws.edu.au/links/ICoMusic/Full_Paper_PDF/Smith_Honing.pdf.

[18] L. M. Smith and H. Honing. A multiresolution model of rhythmic expectancy. In K. Miyazaki, Y. Hiraga, M. Adachi, Y. Nakajima, and M. Tsuzaki, editors, *Proceedings of the Tenth International Conference on Music Perception and Cognition*, pages 360–5, Sapporo, Japan, 2008.

[19] L. M. Smith and H. Honing. Time-frequency representation of musical rhythm by continuous wavelets. *Journal of Mathematics and Music*, 2(2):81–97, 2008.

[20] L. M. Smith and P. Kovesi. A continuous time-frequency approach to representing rhythmic strata. In *Proceedings of the Fourth International Conference on Music Perception and Cognition*, pages 197–202, Montreal, Quebec, August 1996. Faculty of Music, McGill University.

[21] L. M. Smith, S. T. Pope, J. Leboeuf, and S. Tjoa. Automated classification of music genre, sound objects, and speech by machine learning. In *Proceedings of the 12th International Conference on Music Perception and Cognition*, page 943, Thessaloniki, Greece, July 2012. ICMPC/ESCOM. (abstract).