

Group Theory, L-systems, and African Rhythmic Structure

John Belcher
Boston University

James A. Murrell
Suffolk University

Abstract

Much of music structure might appropriately be viewed as auralized mathematics. African and African Diasporic music traditions are areas of untapped potential for exploring this notion, particularly with respect to the ways in which the elements of pulse, cycle, and subpulse are manipulated in complex rhythmic structures. In this paper, we describe our preliminary investigations into the use of group actions and L-systems to generate rhythms based upon the Agbekor bell pattern, a rhythmic structure used in Ewe music and found in many parts of Africa and the African Diaspora.

References

- [1] M. Ascher. *Ethnomathematics: A Multicultural View of Mathematical Ideas*. Brooks/Cole Publishing Company, Pacific Grove, CA. 1991.
- [2] P. Austerlitz. Mambo Kings to African Textiles: A Synesthetic Approach to Black Atlantic Aesthetics. *Glendora Review: African Quarterly on the Arts*, Vol. 3, pp. 115-124, 2001.
- [3] M. Baroni; R. Dalmonte; C. Jacobini. "Theory and analysis of European melody," in *Computer Representations and Models in Music*, A. Marsden and A. Pople, eds., Academic Press 1992.
- [4] J. Belcher. Playing music and doing mathematics. In Proceedings of BRIDGES: *Mathematical Connections in Art, Music and Science*, pages 529-30, Banff, Canada, 2005
- [5] I. Cross. "Music, Cognition, Culture and Evolution," *Annals New York Academy of Sciences*, vol. 930, pp 28-42, 2001.
- [6] F. Donkor. *Oral Teachings (through apprenticeship)*. 1986-88.
- [7] R. Eglash. *African Fractals: Modern Computing and Indigenous Design*. Rutgers University Press. New Brunswick, NJ and London. 1999.
- [8] G. Grove. *Grove's Dictionary of Music and Musicians*. Palgrave Macmillan. 1970
- [9] C. Hazard; C. Kimport; D. Johnson. *Fractal Music*. <http://www.tursiops.cc/fm/#lsystems>. 1999.
- [10] V. Iyer. "Embodied Mind, Situated Cognition, and Expressive Microtiming in African-American Music," *Music Perception*, vol. 19, no. 3, pp.387-414. 2002.
- [11] V. Iyer, Jeff Bilmes, Matt Wright, David Wessel. "A Novel Representation for Rhythmic Structure," in *Proceedings of the 23rd International Computer Music Conference*, (Thessaloniki, Hellas, 1997), International Computer Music Association, 97-100. <http://citeseer.ist.psu.edu/iyer97novel.html>.

- [12] P. N. Johnson-Laird, How jazz musicians improvise, *Music Perception*, 19(5):415-442. 2002.
- [13] G. G. Joseph. *The Crest of the Peacock: The Non-European Roots of Mathematics*. Princeton University Press. Princeton and Oxford. 2000.
- [14] G. Lakoff and R. E. Núñez. *Where Mathematics Comes From: How the Embodied Mind Brings Mathematics into Being*. New York: Basic Books, 2000.
- [15] J. Leach and J. Fitch. Nature, music, and algorithmic composition, *Computer Music Journal*, 19(2):23-33, 1995.
- [16] F. Lerdahl, and R. Jackendoff. *A Generative Theory Of Tonal Music*. Cambridge, Mass: MIT Press, 1983.
- [17] J. McCormack, Grammar-Based Music Composition, *Complexity International*, Vol. 03 April 1996.
- [18] N. McLachlan. A Spatial Theory of Rhythmic Resolution. *Leonardo Music Journal*, Vol. 10, pp.61-67.
- [19] J. H. K. Nketia. *The Music of Africa*. W.W.Norton, New York, 1974.
- [20] M. Nzewi. African Music: Theoretical Content and Creative Continuum, The Culture-Exponent's Definition. *Institut fur Didaktic populärer Musik*. W.D. Luger, Oldershausen, 1997.
- [21] J. Pressing. "Black Atlantic Rhythm: Its Computational and Transcultural Foundations," *Music Perception*, vol. 19, no. 3, pp. 285-310. 2002.
- [22] J. Pressing, Cognitive isomorphisms between pitch and rhythm in world musics: West Africa, the Balkans and western tonality," *Studies in Music* 17 (1983), pp. 38-61.
- [23] P. Pruskiniewicz; A. Lindenmayer; J. Hanan. *The Algorithmic Beauty of Plants*. Springer Verlag, New York. 1990.
- [24] D. Sharp. LMUSE. <http://www.geocities.com/Athens/Academy/8764/lmuse>. 2001.
- [25] F. B. Soddell and JA Soddell. Microbes and Music. *The Sixth Pacific Rim International Conference on Artificial Intelligence (PRICAI200)*. Lecture Notes in Artificial Intelligence Series. Springer-Verlag. 2000.
- [26] G. Toussaint, Mathematical features for recognizing preference in Sub-Saharan African traditional rhythm timelines. *Proceedings of the 3rd International Conference on Advances in Pattern Recognition*, University of Bath, Bath, United Kingdom, August 22-25, 2005, pp. 18-27.
- [27] P. Worth, S. Stepney, *Growing Music: musical interpretations of L-Systems* EvoMUSART Workshop, EuroGP 2005, Lausanne, Switzerland, April, 2005. LNCS. Springer.