

Artificial Life Models for Musical Applications: Workshop Report

Eleonora Bilotta

Centro Interdipartimentale
della Comunicazione
Università della Calabria
Cosenza
Italy
bilotta@unical.it

Eduardo Reck Miranda

SONY Computer Science
Laboratory
Paris, France
miranda@csl.sony.fr

Pietro Pantano

Centro Interdipartimentale
della Comunicazione
Università della Calabria
Cosenza
Italy
piepa@unical.it

Peter M. Todd

Center for Adaptive Behavior
and Cognition
Max Planck Institute for
Human Development
Berlin, Germany
ptodd@mpib-berlin.mpg.de

I Introduction

Music is a complex system shaped by several adaptive processes, including individual behavior and learning cultural and biological evolution. How can we study the origins and change of such a multilevel system? As researchers addressing similar questions in the realm of language have begun to propose, the methods of artificial life (ALife) modeling can be very useful for this type of investigation of interacting dynamic adaptive processes. To explore the possibilities of this approach for the investigation and creation of musical behavior, we organized the first workshop on Artificial Life Models for Musical Applications (ALMMA) at the Sixth European Conference on Artificial Life (ECAL'01) in Prague, Czech Republic. Our goals were to bring together researchers who are developing musical ALife systems to share their ideas and experiences, and to help establish this topic as a promising application of the techniques and approaches of ALife simulation.

The scientific questions that can be addressed through ALife models of music overlap with those considered in ALife models of language: What functional theories of its evolutionary origins make sense? How do learning and evolved components interact to shape the musical culture that develops over time? What are the dynamics of the spread of musical “memes” through a population? But some of the questions (and answers) will be unique to music, especially surrounding the issues of its functional significance (if any) and the creative processes underlying musical composition and production. In addition to considering such scientific questions, the ALMMA workshop participants were interested in artistic applications of artificial life models in music—for

example, how can evolutionary, or agent-based, or memetic simulation systems foster the creativity of human composers? Can we build interesting rhythm generators or melody composers out of genetic algorithms or ecological simulations?

The scientific and the artistic questions and applications should help clarify and inspire each other, but it is also important to keep them distinct, or at least to recognize which questions one is trying to address. Pearce and Wiggins [2] have laid out a useful framework for assessing the motivations of researchers working on models of music composition, which we used to guide the discussions at the ALMMA workshop. Their framework comprises the goals of developing a system to compose a particular individual piece of music, developing systems to help with composition more generally across pieces or composers, modeling a particular musicological theory of composition, and modeling the cognitive processes that go into an act of human music composition. Most of the papers presented at the workshop fell into the first and second category¹.

During the welcoming speech, Eduardo Reck Miranda introduced three approaches to ALife and music research: *generative*, *engineering*, and *musicological*. The generative approach is mostly concerned with mapping the behavior of ALife algorithms onto musical processes. This type of research is principally being developed by composers with an avid interest in ALife, who are primarily interested in studying the behavior of such algorithms and devising ways of implementing musically interesting mapping schemes. The engineering approach is motivated by the potential of evolutionary techniques to solve practical problems concerned with optimization of software for musical applications. Most research here involves the use of genetic algorithms and genetic programming to solve software engineering problems. Finally, the musicological approach develops theories of music inspired by ALife paradigms, such as the notion that music is an adaptive complex dynamic system. Researchers here are mostly interested in developing models for studying the origins and evolution of music.

2 Snapshots of the Papers

Igor Yevin and **Alexander Koblyakov** made an analogy between brain activity, Hopfield's neural network model, and cognitive models of musical productions and the dynamic features of musical tonality.

Michael Prerau wrote about an analytic synthesis system for generating music created by construction-based genetic algorithms. The objective of this system is to analyze several user-selected musical works and create a new piece of music that will retain desired characteristics present within the input compositions.

Eleonora Bilotta and **Pietro Pantano** reported on a semiotic approach for the construction of musical codes to produce music by using cellular automata systems. The emergent behavior of complex cellular automata rules is analyzed and the main elements of the systems are used to produce music. The objective is to arrive at a grammar of musical composition using cellular automata, and to try to understand the complexity of cellular automata by means of the musical medium.

Mikhail Malt wrote on growing an artificial musical society, exploring the implementation of a model of autonomous agents to foster musical creativity by allowing the evolution of musical materials by genetic transmission. In this way he could associate the ideas of variation and interpolation in musical composition.

James Mandelis (whose paper was presented by Phil Husbands) gave an overview of Genophone, a hyper-instrument for the creation of new sounds that can be changed during a performance. He introduced a "selective breeding" paradigm as a solution for creating various synthesis techniques.

¹ In the future, we hope to see more works that fall in the fourth category: scientific investigations of the composition, cultural creation, and evolution of music.

Rodney Berry presented demos of four ALife worlds, all musical installations populated by agents that can move, reproduce, forage, and so on, and produce sound accompanying their other behaviors, thus creating music. He discussed some of the issues involved in the process of designing artistically interesting musical installations, and directions for future improvements.

Sam Woolf (in collaboration with **Adrian Thomson**) introduced an interactive and adaptive sound installation, The Sound Gallery, that makes use of various sound sources that are processed through evolvable electronic circuits. The flux of sound created changes as people move around the installation space, while the electronic circuits are constantly manipulated and reconfigured through a process of artificial evolution, driven by aesthetic selection pressures.

Rodney Waschka II used evolutionary techniques for developing the chamber opera, *Sappho's Breath*. The program used in creating the work, called GenDash, aided in the composition of arias consisting of single-line vocal music. The problem addressed is how to use artificial life models in the creation of new music that is unique and therefore requires unique treatments in terms of acoustics, aesthetics, and cost. Excerpts from the opera were presented at the workshop.

Eduardo Reck Miranda discussed using the emergent behavior of cellular automata to model generative processes for sound synthesis and musical forms. The Chaosynth system uses granular synthesis with parameters controlled by cellular automata (<http://www.nyrsound.com>). The CAMUS system uses the pattern propagation properties of cellular automata to generate musical forms.

Ricardo A. Garcia described an approach to automating the design of sound synthesis algorithms (SSAs) by means of evolutionary methods applied to custom descriptions of SSAs in the form of cyclic topology graphs with ordered branches between simple arithmetic operators. Evolution works at two levels, suggesting topological arrangements for the SSA functional elements and optimizing their internal parameters. This approach can create topologies for rendering sounds similar to a target sound (based on aural fitness criteria), but often in surprising ways.

Jonathan Impett, using the Swarm simulation environment, developed a model for implementing interactive music instantiated in real time on the basis of local performance and environmental information. The author used a rich variety of modeling principles in which the interplay of interaction, simulation, and invention create the background for musical composition. The Swarm architecture proposed is able to trace and infer some aspects of a live musician's performance (harmonic or stylistic or compositional rules), and reproduce and evolve them in real time.

Alexander Mihalic presented a paper in which musical composition is based on data stemming from the genetic code. The method uses a set of 20 musical groups, which represent the 20 amino acids coded by DNA. The compositions are written for a monophonic instrument like flute, clarinet, or saxophone. The author has created a database of musical examples produced from different types of DNA.

3 Conclusion

The scenario that ALife science reveals to musicians is completely unexpected. New methods, paradigms, and tools for studying, producing, managing, and creating music are available now [1].

From cellular automata to genetic algorithms and agent-based applications, the workshop offered a rich variety of musical compositions that made use of ALife methods and techniques. It seems that ALife models can help in investigating and researching more expressive and creative music realizations, both in performing and in composing musical pieces. Another important aspect is the creation of new instruments. The

workshop suggested that musicians are attempting to contribute new methods to the improvement of a new kind of musicology that tries to develop alternative quantitative and qualitative models and theories of musical expression.

The next ALMMA workshop will take place as part of Artificial Life VIII, the 8th international conference on artificial life, to be held in Sydney, Australia, in December 2002. During the conference, we would like to dedicate one evening to a special event: a concert, which will be the cooperative work by researchers who are interested in realizing ALife music.

Future workshops will present the latest work on topics such as understanding music evolution through ALife simulations, music as emergent social behavior, genetic algorithms and neural networks for music, musical cellular automata, ALife-based models for music composition, and so on. They will also provide forums for continuing our discussions of the fundamentals of musical ALife models, including the appropriate research methods and validation procedures for such applications, as well as their benefits to the scientific community and to musicians and artists. We hope that at future workshops, as at the first one, researchers from the fields of psychology, biology, computer science, simulation modeling, robotics, engineering, and beyond, all with a common interest in music will come together again to discuss both the music implications of their work and its relevance for the wider field of artificial life. An electronic version of the first ALMMA workshop will be available at the following web site: <http://galileo.cincom.unical.it/esg/music>.

References

1. Bilotta, E., & Pantano, P. (2002, in press). Synthetic harmonies: Recent results. *Leonardo*, (35) 2.
2. Pearce, M. T., & Wiggins, G. A. (2002). Why automate the compositional process? Manuscript submitted for publication.