Musical Agents: Towards Computer-Aided Music Composition using Autonomous Software Agents

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Palle Dahlstedt was awarded a fellowship to work within the Department of Computer Science at the University of Liverpool on a research project tasked with (a) developing a software tool that would allow composers to work with self-directing "computational entities" and then (b) using the software tool to create a new musical work. The project title was "Computer-Aided Multi-Agent Music Composition." The award holder was Peter J. McBurney.

This project was a collaboration between a composer (Dahlstedt) and a computer scientist who works in Artificial Intelligence (McBurney). Although these disciplines are not often viewed as being related, there was considerable overlap in our backgrounds and interests. Dahlstedt is a composer who has worked in the area of generative music, using advanced computational methods and techniques (such as evolutionary computation) in his compositions. McBurney has had a long-standing interest in contemporary music, particularly in formal and mathematical models of music. The two of us first came into contact after McBurney heard a British radio broadcast of Dahlstedt's *Anakolut*, a video and electronic music composition [1].

The interdisciplinary nature of the project has created no difficulties in our collaboration. Our research effort proceeded through joint discussions and brainstorming sessions, of the sort common in the early stages of complex software design, along with individual work in software development. Perhaps because of the large overlap in our backgrounds and research interests, and because of the similarities in our musical tastes, our collaboration has been enjoyable and rewarding.

Software Agents

McBurney's computer science research is in the area of multi-agent systems. These are computer systems in which software entities (called *agents*) exhibit some degree of intelligent behavior and autonomy as they interact with one another and with human beings. The Internet can be viewed as one large, multi-agent system, with each computer connected to it appearing to be an autonomous, intelligent agent. The design and implementation of agent systems create many conceptual and practical problems for computer scientists and software engineers, and the paradigm is leading to a revolution in the design and implementation of distributed computer systems and complex software applications.

We wondered if the agent paradigm could also be applied to music. Thus, the primary aim of our collaborative research project was to assess whether multi-agent ideas could be used to aid understanding of music and processes of musical composition. A second aim was to turn these ideas, if applicable, into software and techniques that would aid composers in the compositional process, including a prototype software program for a generative music installation. Finally, we ourselves hoped to use the techniques and tools to compose music.

Because the discipline of Artificial Intelligence (AI) is still in its infancy, the methods used in AI research are eclectic. In

modeling mental processes, for example, introspection, self-reflection and narrative are common techniques, just as they are in anthropology or in literary criticism. Similarly, as in engineering, research in AI is often undertaken through the construction of artifacts, whose properties are explored upon completion or even through the process of construction itself. Theoretical development often follows practical implementation of these artifacts, as has occurred with the Internet (which still lacks an adequate formal theory).

In our case, the artifact is a prototype software system that will generate music. As we progressed through the design and specification stages of creation, we decided upon a multi-agent model in which the agents are distinct, goal-driven software components representing different compositional processes and heuristics. For example, as time elapses, one agent is tasked with removing sound objects from the system's sound landscape when the landscape is thought to be too cluttered, while others fill in gaps in the musical texture (Fig. 1). In developing these agents, we drew upon Dahlstedt's reflections on his own compositional processes. This experience of introspection and reflection will have lessons for the computational modeling of creative processes, a subject of current interest in AI [2].

In order to ensure that the music generated by the system is not bland, we were led to create a system capable of producing outputs that are not expected or predictable---in other words, a system that exhibits what a computer scientist (or a researcher in complex systems) would call *emergent properties*. But in generating such properties, the artifact begins to assume its own life, beyond that of its creators. In particular, this raises questions common to generative music, such as, *Who is the author of the output of such a system?* In this case, music is the output, and there are several moral claimants to the role of composer: the program creator(s), the software program (the

artifact) itself, or the person who executes the program (and who may provide inputs needed to make it run).

Research Progress

After the initial system design, Dahlstedt developed a collection of discrete sound program modules, to form part of the software infrastructure of the generative software prototype. We are currently still developing the prototype, as well as working on papers describing our work. The research objectives of the project have proven more difficult to achieve than anticipated, mainly due to the immaturity of the agents paradigm and hence the absence of appropriate design and specification tools. Thus, although project funding has now ended, we continue to work together towards completion of the project objectives. The outputs of the project to date have included the sound program modules along with conference presentations and demonstrations in Sweden and Britain, given both jointly and separately.

References and Notes

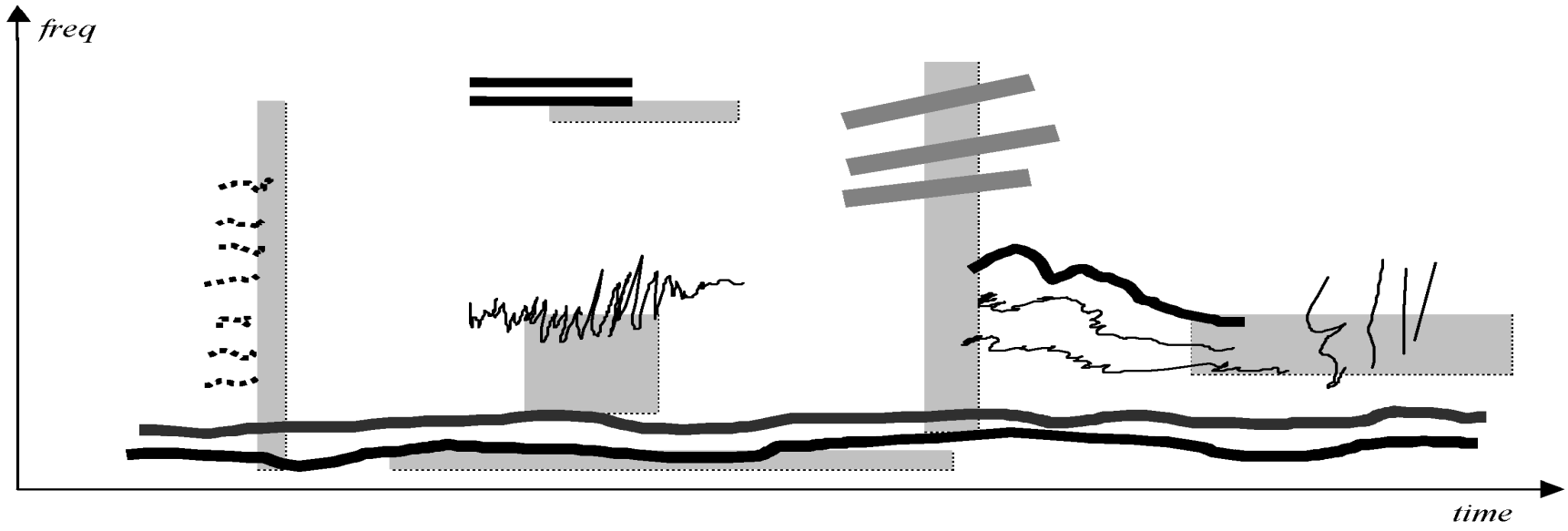
1.
Dahlstedt's *Anakolut* was broadcast on *Hear and Now,* BBC Radio 3, London, U.K., on 30 September 2001. This work won the 2001 Gaudeamus Prize.

2.
This issue is also related to the social science research undertaken alongside these fellowships.

Figure Caption

Fig. 1.
A number of agents of different width and height, marked as light gray rectangles, move around a symbolic sonogram representing a

number of sound objects, analyzing the musical contents currently within their borders. If they find that there is too little musical activity on their current location, they create a new sound object, tailored to fit the local musical context. If they find that there is too much activity, they can remove sound objects. These creative and destructive actions together create a varying musical texture. (Image <c> P. Dahlstedt and P. McBurney)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