

# Experiments in Agent-based Sonic Composition

**Andreas Duus Pape**

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## **Abstract**

John Cage's "Music of Changes," which was composed using a random component from the iChing. . I perform and write music, normally acoustic, and usually for a single guitar, harmonica, and voice. I am traditional in my choice of instruments, they are basically "old" technology.

## **Keywords**

Music (Subfield), Aesthetics, Article, Economics, Music, Sound Studies

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<https://youtu.be/Yn3QZw0vLY>

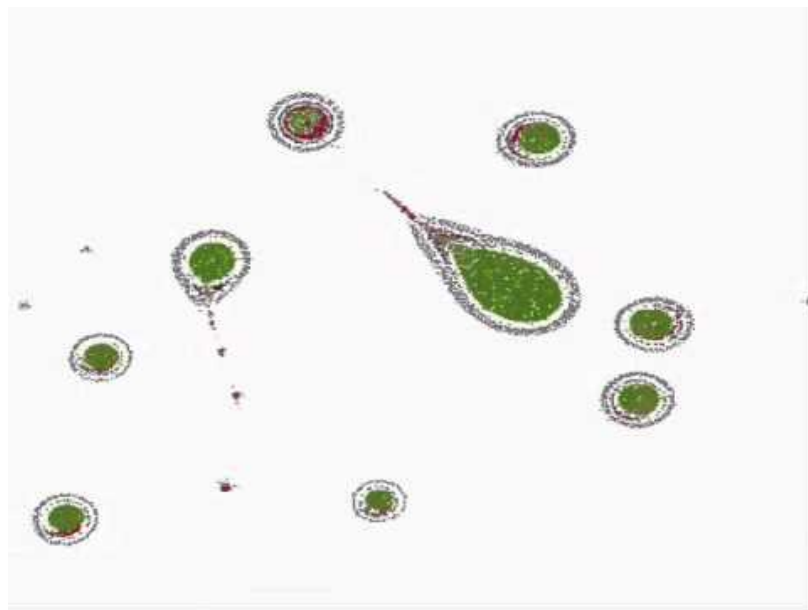
*John Cage's "Music of Changes," which was composed using a random component from the iChing.*

I perform and write music, normally acoustic, and usually for a single guitar, harmonica, and voice. I am traditional in my choice of instruments, they are basically "old" technology. On the other hand, I am also fascinated by the idea of robotics in music. The idea of artificial, autonomous music creators that work alongside human musicians. John Cage used the *iChing* to make choices about musical form in some of his compositions, including "Music of Changes" above, which has some of that flavor. It is music that is composed, not just performed, by a partially artificial means—by a non-human actor, the *iChing*.

In my work as an economist, I develop autonomous software programs that simulate economic actors in a process called agent-based modeling – the construction of independent pieces of software, which simulate real agents in the world, that interact and form patterns that transcend any single agent's behavior. Recently I realized that agent-based modeling might be able to be applied to the construction of music: creating individual artificial decision makers which might together construct a piece of music that transcends what any one of them can do.

Think of a swarm of bees or a school of fish. Once biologists thought that schools of fish had a 'leader fish,' a single fish that would direct how the school would move. Biologists also once thought that the queen bee was the 'leader' of the hive, that it directed behavior of the bees in the hive. Both of these beliefs have been shown to be false. There is no leader in a school of fish. On the contrary, each fish responds to local information and then the co-ordination which arises on the school level emerges from this system of individual choices. The same with bees...the queen plays a part in the hive, like all the bees play parts, but there is no sense in which she directs the others. There is no bee that is in charge.

Here is a video of my colleague Hiroki Sayama's 'Swarm Chemistry' in action. The specks you see on the screen are individual agents, dumb agents, who react to their environment, which is other local agents. There are no leaders here, there is only group behavior.



<https://youtu.be/lcBTk2fqGe4>

In this clip, you can see the swarms which emerge. The music is incidental in this clip; not a result of the swarm behavior.

I have begun an experiment in agent-based sonic composition with the idea of emergent behavior and agent-based modeling in mind. In this video I show my initial foray into this world:

<https://vimeo.com/34706937>

The agents in this video are small triangles that seek a well, and eventually learn (sometimes more effectively, sometimes less effectively) where that well is. What I have done to add a sonic component is to assign each agent an instrument, and assign the agent's proximity to the well to the pitch of the note they create.

"Random" sounds created by a computer are nothing new. And, frankly, I find them uninteresting. No depth, no humanity. But I think agent-based sonic composition might be something different. These agents are not simply random (although indeed, their behavior has something of a random component, or seemingly random component). They are goal-seeking, they are purposeful, and the sound they generate is a function of their effectiveness and path in pursuing that goal. I think this purposefulness can be heard in the sound they create. There certainly isn't a melody, but there is a story being told, some kind of struggle being documented.

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Swarms, too, are not simply random. Though swarms may be composed of elements that have randomness in them, they are also structured. If Music is sound with structure, and complex systems is the study of emergent structure, there could be a genuinely interesting music that might emerge from a well-constructed agent-based approach to sonic composition.

I'm not convinced what I have is there yet. There are not interesting interactions between these agents, and there is not a structure to their sound that has depth – yet. Perhaps the next step is to tie the goals of the agents more explicitly to music making. Perhaps there can be melodic agent who moves on a predetermined path, and the other agents try to follow that agent, and hence the sound that comes out documents their struggle. Maybe the agents' notes should be restricted to scales, so that it sounds less chromatic. Or, perhaps, as I suggest in the video, there can be some agents which control rhythm and others that control pitch.

To be clear: I wouldn't just listen to this. I don't know if I would call it "music" yet. But I think it may get there some day.

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*Andreas Duus Pape: is an economist and a musician. As an economist, he studies microeconomic theory and game theory—that is, the analysis of strategy and the construction of models to understand social phenomena—and the theory of individual choice, including how to forecast the behavior of agents who construct models of social phenomena. As a musician, he plays folk in the tradition of Dylan and Guthrie, blues in the tradition of Williamson and McTell, and country in the tradition of Nelson and Cash. He plays acoustic guitar, harmonica, and voice: although the technology of his musical production is a hundred years old, his ideas are often quite modern, and he covers songs as old as early last century and as recent as this one. Pape is also an assistant Professor in the department of Economics at Binghamton University, where he teaches microeconomic theory at the undergraduate and graduate level. He is a faculty member of the Collective Dynamics of Complex Systems (CoCo) Research Group: <http://coco.binghamton.edu> and considers complex systems and agent-based modeling to be central to his research*