A musical extravaganza!

Research into the evolution of music may lead to a breakthrough in the boundaries of music creation in the future. By **Vanessa Knivett**.

The term 'Evolutionary Music' conjures a kaleidoscope of images. And if you say that it has something to do with artificial intelligence, the pictures in your head don't become any less surreal. Herbie Hancock it isn't. A simple definition would be 'teaching computers to compose', but the reality is that it goes much further.

Evolutionary music researcher Dr Eduardo Reck Miranda is a reader in Artificial Intelligence and Music at the School of Computing at the University of Plymouth. He explains: "This research addresses the possibility of implementing collective generative music systems, using virtual musicians who learn how to compose and play by themselves and with people interacting with them. It's driven by a wish to know how music has evolved within human society."

Dr Miranda has recently worked at Sony's Computer Science Laboratories in Paris, where his researches were aimed at creating systems capable of composing original music with minimal input. Using the process of 'musaicing' – a contraction of musical mosaicing – Sony hopes to create AI systems that can respond to the complex sounds and nuances of human speech.

Evolutionary music, a term coined by Dr Miranda, has been inspired by evolutionary computing, a technique which has itself emerged out of more traditional artificial intelligence techniques. Dr Miranda explains: "At the end of the 1970s and beginning of the 1980s, people thought about developing more friendly ways of using computers, which meant giving some kind of intelligence to them. This was mostly done by modelling natural language. However, there have been limitations as this is done by defining a set of rules to which the computer works. The problem is our inability to create a complete set of

crucially, listen and react to the sounds produced by the other robots. The objective is to see how realistically they would behave compared to a software simulation. The study has implications for musical development. Imitation has always been an important factor in the development of music, but what still hasn't been discovered is the conditions are necessary for different groups of people to evolve different sounds.

Dr Miranda acknowledges that commercial opportunities are still some way in the future, but he suggests the possibility of using the virtual musician concept for mobile 'phones. "Each agent could be embedded into the telephone so that, in the background of the call, they could exchange musical information. The concept could be used to build a repertoire – some collective, generative ring tone that suggested the personality of a group of people."

Dr Miranda has already used material generated by Camus to compose a number of professional scores for a chamber orchestra and these have been demonstrated to great success in a number of public venues, including at the Edinburgh Festival. Dr Miranda observes: "Presenting the score publicly has been very rewarding. People are always shocked when they find out where the music has come from as it is very pleasing to the ear." Indeed, Dr Miranda has published a soundtrack of Camus generated material through a music label in his native Brazil.

The research world has also recognised his achievements. Dr Miranda is now effectively creating a centre for Computer Music Research at the University of Plymouth, which will foster research in various areas of computer applications in music, including the development of this project on evolutionary music. Topics which will come under the remit of the Computer Music Research centres include computer aided musical composition; software sound synthesis; musical networks; distributed musical intelligence; music technology in education; and the neuroscience of music.

There are a number of opportunities for overlap elsewhere in the University that the centre will help to explore. One, for example, is the Institute of Digital Arts and Technology's Cybrid project, which is aimed at developing intelligent operational systems for smart buildings by integrating media technologies into architectural design.

One of the main objectives of the project is to capture information about the activities that take place within a building by means of thousands of embedded sensors and to make this information available for research, education and artistic purposes.

The Cybrid Audio project is aimed at the design of generative music systems that function according to the activities that take place in a smart building.

Another project into which the centre for Computer Music Research's work may filter, is being carried out by the University's Neuroscience of Music group. One of the group's objectives is to develop technology that will allow the brain to interface with musical devices. The project not only aims gain a better understanding of the underlying neurology of musical processing, but also to develop the know how to build innovative portable music devices. Included in this grouping are devices that play specific types of music according to the user's state of the mind, along with sophisticated equipment for music therapy.

Meanwhile, Dr Miranda has much to do to take the 'adaptive agents' project further. He notes: "My objective is to scale up the evolutionary music experiments. At the moment, the agents can only produce simple melodies; they cannot compose real music yet. In order to compose real music, these agents will have to be furnished with more sophisticated brains. To this end, I am starting to look at the research being developed in the field of neuroscience in order to gain a better understanding of the brain from a musical perspective and to study music from a neurological perspective."

The centre will be working in close collaboration with the centre for Theoretical and Computational Neuroscience to furnish Dr Miranda's musical agents with more sophisticated brains and to study what is happening in the brain when we listen to music. NE

Dr Miranda: "In order to compose real music, these agents will have to be furnished with more sophisticated brains."

rules, which means that managing current expectations is a difficult task."

He adds: "This 'failure' originated an approach that suggested that if you cannot find all the rules, how about programming skills into computers to allow them to find their own rules? Hence, the quest for machine learning algorithms, the birth of neural networks and subsequently evolutionary computation – that is the use of ideas inspired from Darwinian evolution theories."

Dr Miranda has been studying the origins and evolution of music with computer modelling techniques similar to the ones used by evolutionary linguistics for a number of years. He believes that one the greatest achievements of AI to date lies in the construction of machines that can compose music of incredibly high quality. "However, these AI systems are only any good at mimicking well known musical styles. They are either hardwired to compose in a certain style or able to learn how to imitate a style by looking at patterns in training examples."

Essentially, this has meant that whilst computers have been quite able to compose a new Mozart requiem, they have, as yet, been unable to come up with anything completely novel. Dr Miranda believes that to truly enable a computer to make music, a particular learning model must not be embedded at the outset. Rather, the idea is to program it with abstract models that, says Dr Miranda, "convey some form of emergent behaviour resembling natural phenomena; for example, cellular automata, genetic algorithms and adaptive games, to cite but a few."

Dr Miranda began his research by creating two computer programs which use cellular automata as the starting block – a software synthesiser called ChaoSynth and a generator of musical passages called Camus.

The cellular automata are organised as an array of identically programmed 'cells' arranged in a 2D grid. Each cell is able to communicate with others, but only with its nearest neighbours. Music evolves through a pattern created by repeated application of each cell's rule set. ChaoSynth then translates this pattern using a granular synthesis method into a signal that can drive a speaker. By accumulating a sequence of short sound 'grains' – each typically 10 to 100us long – many different cells can contribute to the final sound sample.

Latterly, Dr Miranda has created 'adaptive agents', which consist of very simplistic software programs. Each of these has a musical instrument embedded, an 'ear' and a memory. These adaptive agents are like virtual musicians – each with an 'enacting script' which determines how they interact with one another.

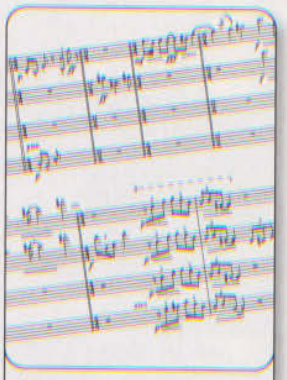
In the case of Dr Miranda's current experiments, each musician or agent has been equipped with a voice synthesiser – eventually, though, they could be equipped with a range of musical instrument synthesisers. Each is encapsulated as a single program, with several set to run in parallel. In effect, the agents make sounds to each other, listen and learn from each other.

Dr Miranda continues: "The motivation of the agents is to form a repertoire of tunes in their memories and to foster social bonding. In order to be sociable, an agent must form a repertoire that is similar to the repertoire of its peers. Sociability is therefore assessed in terms of the similarity of the agents' repertoires."

Among the questions the research aims to answer is what are the appropriate agent interactions and what motivates them, what are the proper cognitive and physical abilities of these agents and also, what environmental constraints are necessary to foster music evolution? Dr Miranda says: "We believe that the evolutionary simulations with which we are experimenting have the potential to reveal new fundamental aspects of our musical creativity that are waiting to be unveiled."

However, more commercially orientated opportunities may also arise out of Dr Miranda's studies. "From a pragmatic perspective," he says, "we are interested in developing new technology for implementing autonomous generative music systems. Instead of modelling specific styles of music or compositional processes, we are looking for ways to implement collective music making systems, using virtual musicians who learn how to compose and play by themselves and with people interacting with them."

Dr Miranda has already begun to pursue an approach that might have more of a commercial angle. Working with other members of the University of Plymouth's School of Computing, Dr Miranda will be programming simple robots to walk, play a simple percussion instrument and,



An excerpt from the second movement of *Wee Batucada Scotica*, a string quartet commissioned from Dr Miranda by the University of Glasgow. A significant part of this movement was generated by CAMUS, a cellular automata based music composition system.

Dr Miranda has been studying the origins and evolution of music with computer modelling techniques similar to the ones used by evolutionary linguistics for a number of years.