COMPUTER SCIENCE

# Algorithmic rapture

**Philip Ball** listens in on an album of evolved music composed by the Darwinian computer program Iamus.

If a computer can produce an artwork that moves us, does it take artificial intelligence beyond an important threshold? That is one of the questions raised by Iamus, an algorithm that composes music from scratch, developed by Francisco Vico and his colleagues at the University of Malaga in Spain.

*Iamus*, an album of compositions by the algorithm — including two orchestral pieces played by the London Symphony Orchestra — comes out on 1 September. A live performance of several Iamus pieces was broadcast in July to commemorate the centenary of the birth of British computing pioneer Alan Turing.

The recordings, scored for a variety of chamber and orchestral ensembles, are at the very least musically 'plausible', and some listeners have found them stimulating, both intellectually and expressively. They should provoke lively discussion.

Composers, most notably the experimentalist Iannis Xenakis, have been using computers to make music since the 1960s. And there is nothing especially new about an algorithmic approach to composition: the rule-bound, even formulaic, nature of most music lends itself to that. A program called CHORAL, devised in the 1980s by computer scientist Kemal Ebcioğlu to harmonize chorales in the style of Johann Sebastian Bach, drew on principles of harmony and melody observed by Bach himself.

Computer scientists have also succeeded in making programs that learn from human examples. Even their creators admitted that early improvisational algorithms such as GenBebop, created in the early 1990s by cognitive scientists Lee Spector and Adam Alpern to produce jazz solos in the style of Charlie Parker, gave indifferent results. The Continuator program, devised a decade later by François Pachet at the Sony Computer Science Laboratory in Paris, is much more convincing, particularly when it elaborates on improvisations by a human pianist.

It is quite another matter, however, for a computer to come up with captivating music without relying on human input for the raw ideas. Before now, such efforts have often sounded like pastiche, using clichéd harmonic progressions and melodic structures.

This is where Iamus's creators claim to have something new. The algorithm is inspired by Darwinian evolution. It is named after an ancient Greek hero, son of the god Apollo, who could understand the language of birds. The computer generates very simple 'musical genomes' — little motifs that are evolved, mutated and elaborated until they acquire genuine musical content and interest. Genetic and evolutionary algorithms
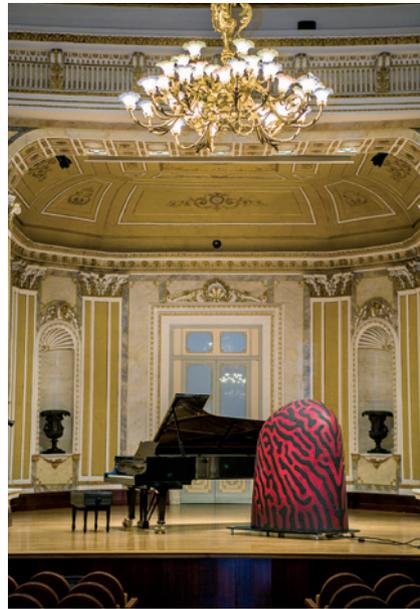


**Iamus awaits performers and audience to begin making music in Sala María Cristina, Spain.**

for making music have been seen before, but Iamus's approach of unfolding complex structure from a mutable core has enabled the kind of dramatic invention found in biological evolution. The music is far more than just a succession of transparent variations.

The recorded pieces are all in a modernist classical style — full of dissonance, but with hints of harmony and rich textures that are reminiscent of works by, for example, György Ligeti and Krzysztof Penderecki. However, the same approach can be used for other idioms, and Vico and his colleagues say that similar algorithms could generate music for commercial purposes.

The willingness of professionals to perform the works marks Iamus as unique. Lennox Mackenzie, chairman of the London Symphony Orchestra, was impressed with what the algorithm had achieved, although he felt that its scores still fell short of good human compositions. The music struck him as "going nowhere" — a complaint often made of other modernist works — yet ultimately achieving an "epic" quality. Many other musicians were pleasantly surprised by the material, and found some of it genuinely expressive.

**Iamus**
IAMUS
MELOMICS RECORDS: 2012. €14.95

Which brings us back to the initial question. If Iamus can simulate (and thus stimulate) emotionality, is it not merely 'thinking' in the limited sense meant by Turing when he proposed a test for artificial intelligence, but also displaying human characteristics?

Here we should heed studies of music cognition, which have shown that emotion in music is not some deeply mysterious process, but has its own rules and regularities, as discussed by psychologist John Sloboda in his books *The Musical Mind* (Clarendon, 1985) and *Music and Emotion* (co-edited with Patrik Juslin; Oxford University Press, 2001). For example, certain musical structures, including judicious injections of dissonance or 'false trails' that create and then confound expectation, can elicit emotions quite reliably — as anyone whose feelings have been manipulated by formulaic film scores can attest.

What is more, the involvement of human performers is vital. The same notes can be performed drily and without engagement or with heart-rending fervour. Good performers achieve expression with a wide range of techniques, such as subtle distortions of tempo, intonation and timbre.

Iamus's work might therefore be considered to demonstrate the role of performer and audience in 'making music'. It does not deny the sensitivity and skill of the greatest composers to say that a composition becomes music in the mind of the listener only through the interaction of the composer's and the performer's choices with the wealth of learning and association that even allegedly unskilled listeners possess.

This consideration ought to diminish a widespread prejudice against computer-composed music that has been evident in the critical responses to Iamus so far. Neuroscientists Stefan Koelsch and Nikolaus Steinbeis have shown that part of this prejudice is unconscious: the same piece of music may or may not activate parts of the brain associated with ascribing intention to others, depending on whether listeners have been told that the piece was composed by a human or by a computer (N. Steinbeis and S. Koelsch *Cerebral Cortex* **19,** 619–623; 2009).

Human performance of computer-made music might at least partly override this obstacle to emotional engagement. We should also celebrate the way that Iamus, far from threatening humanity's supposedly unique claim to creativity, can put the audience back in the picture as a participant in the creative act. ■

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