Music as defined by computer

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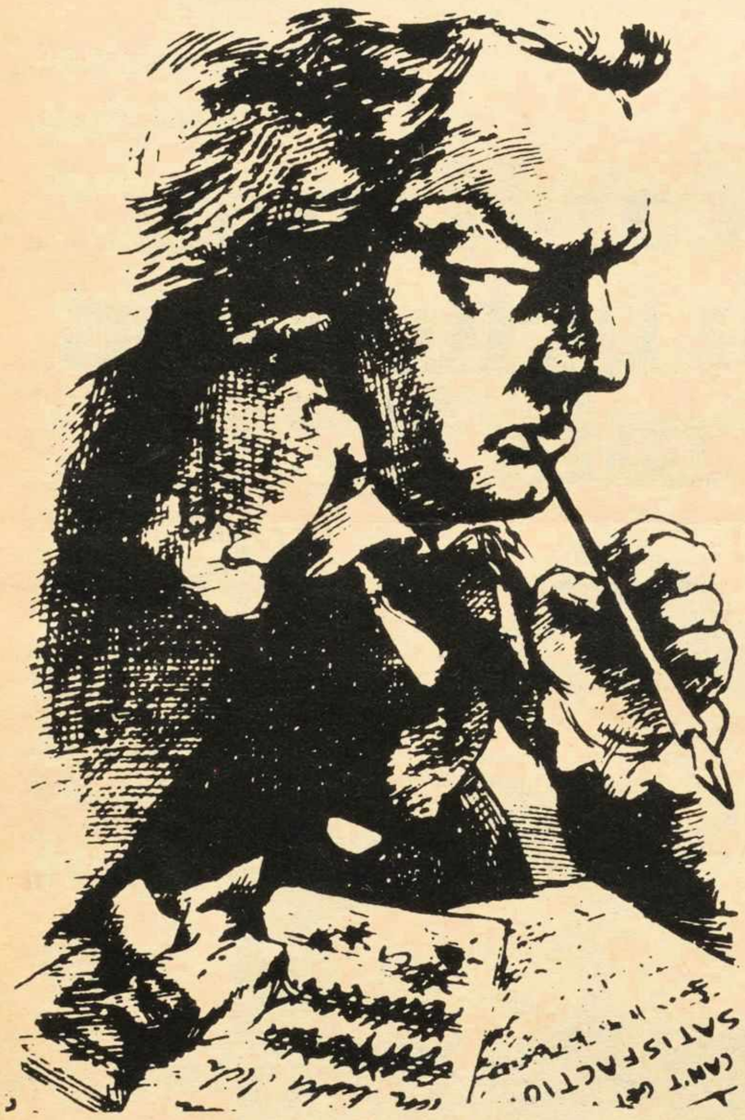
Although it may be a few years before The Stack Overflow Blues, or I left my CPU in San Francisco will be climbing to the top of the music charts, the role of the computer in music composition looks bright. Despite research in this area for more than two decades, workers had not been able to tune into success. However, two scientists have achieved a recent breakthrough in understanding the statistical mathematical relationships which define music.

Computer-generated music dates back to 1956 when Push Button Bertha was composed on a Datatron computer. However, the most significant research was directed by Lejaren Hiller at the University of Illinois, where the ILLIAC suite for string quartet made its debut, later that year.

Very early in computer-music research, it became obvious that a detailed analysis of the mathematics of music was necessary.

More recently, music has been subjected to far more detailed analyses, often using a computer. James Beauchamp, a professor of electrical engineering at the University of Illinois, and one of the current leaders in the field of computer-generated music, devised the following four-part analysis, which is executed by a CDC 1604 computer.



1. A frequency correction routine computes the average frequency with one or more passes.
2. A heterodyne operation creates the sine and cosine functions for each harmonic.
3. The Fourier coefficients a(k) and b(k) are obtained using a filter operation.
4. The harmonic amplitudes and absolute phases are computed using the right triangle solution.

This method gave rise to the composition Sonoriferous Loops in 1964.

Lejaren Hiller conducted several experiments using musical laws to compose music. In his first attempt, random numbers were modified by 14 screening instructions based upon musical laws. The tunes produced were, however, too monotonous, especially the rhythm. An improvement was achieved using only 4 screening instructions.

In an attempt to create purely mathematical music, Hiller used probability functions instead of random number generators. From these experiments, the computer program MUSICOMP was developed. Three of its accomplishments were the pieces Sonatina for CDC-3600, Algorithms I and II, and Computer Cantana in five parts which was played by U of I's chamber orchestra.

The present MUSICOMP program is a collection of dozens of subroutines—almost a language in itself.

Some of their functions are to: choose the stochastic order of the probability functions, generate frequency distributions, generate and modify phrases, generate rhythms, control other routines to induce irregular rhythms including delayed resolutions and anticipations, and resolution of odd-tone intervals to harmonics.

In addition to the development of computer-composed music, research has also been aimed at enabling this music to be synthetically generated, eliminating the need for trained (and often expensive) musicians.

One of the pioneers in this area was Brun, whose above-mentioned computer-composed music was transposed for performance by two programs; an instrumental program which wrote the scores for the musicians, and a tape program, which produced a control tape for a CSX-1 synthesizer.

By varying some of the parameters obtained from this procedure, and operating it in reverse, music can be composed.

A more variable and general analysis, devised by Herbert Brun, a professor of music at the University of Illinois, is given below:

1. Analysis and synthesis of acoustical phenomena and their controlled and recorded phenomena.
3. Structural analysis of music logistics and logics and their synthesis by computer programs.
3. Attempts at an evaluation and application of thoughts and ideas with regard to musical aesthetics and forms created by the composer/technology interface.

While the composing program used filters, shape, density, and fluctuation control according to music rules, the tape program controlled the timbre and colour of the sound to be produced.

Further work has been done in this area by Barry Vercoe, now at M.I.T., who developed the program MUSIC360 for the IBM 360 computer series in 1969. This program allows the user to specify the timbre—the instrument's harmonic pattern—and envelope—the instrument's sound volume rise and decay time—for as many instruments as desired. Thus either conventional instruments can be synthesized, or completely new sounds devised.

With such a sound transposition program, music generated by either a computer or a composer him/herself can be immediately realized.

With all the study of classical and contemporary music patterns, it is nothing short of amazing that the latest breakthrough in music generation is the result of noise analysis. Limited experimentation in this area was done by James Tenny, who examined noise patterns and incorporated these patterns and parameters into music several years ago.

Lately, Richard Voss of IBM and John Clarke of the University of California, have discovered a subtle mathematical relationship between the pitch and loudness of any one note and all other notes in the piece. This is the characteristic one over f noise (1/f), a fluctuation found in many natural noises such as traffic, factory and construction noises, etc., which is remarkably statistically consistent regardless of source or time scale.

Having analysed a wide range of musical styles from classical to rock, Voss has found a very close correlation to the 1/f statistics. Thus, by reversing this process, quality music can be generated by a computer.

Voss has suggested that the 1/f relationship between any given note and all others in the composition gives music a sense of unity which, although subtle, is perceived by the listeners. As for that age-old question "what does music really imitate?", I'll leave it up to you.