COMPOSITIONAL USES OF RANDOMNESS

in **Computer music** Ch. DODGE & Th. A. JERSE
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Lejaren Hiller is the first composer to have extensively investigated computer aided composition. Among many other compositions, the *Illiac Suite* (1957) is a didactic piece that demonstrate particular compositional techniques.

The programs for the *Illiac Suite* were developed by Hiller and Isaacson in the mid-1950s. For this piece, the Illiac computer at the University of Illinois generated the pitches, rhythms, and other characteristics of the music. The computer printed the results in an alphanumeric code that was transcribed by hand into music notation and then scored for string quartet.

Hiller and Isaacson used random processes to generate the music of the *llliac Suite*. Although the notes were generated at random, the composers wanted some degree of control. Therefore, restrictions were built into the process. A "generate and test" method was applied : each random selection generated was rejected if it failed one of a number of tests of its suitability.

The first three of the four movements of the *llliac Suite* was produced by the "generate and test" method. These compositional "experiments" were modelled on pre-existing types of music. For example, the melodic and harmonic activity in the first movement were controlled by the rules of cantus firmus and species-counterpoint composition described by Fux in *Gradus ad Parnassum (Vienne, 1725)*. In this movement, the "test" questions were designed to determine whether each randomly generated selection conformed to the rules for melodic succession and harmonic consonance of first-species counterpoint.

The computer program produced random integers in the range 0-15, which represented the tones of two octaves of diatonic "C." Melodic rules were then applied to the randomly generated diatonic pitches to determine their acceptability. Some of the rules of first-species counterpoint used in the first movement were : no melody was allowed to exceed the range of one octave ; the melodic line had to begin and end on a member of the tonic triad ; melodic leaps of sevenths were forbidden ; and under most circumstances, it was prohibited to repeat the highest note of a melodic line. Among the harmonic tests applied to the generated tones were : Only consonant intervals—unison, octave, perfect fifth, major and minor thirds and sixths—were permitted ; and the perfect fourth was treated as a dissonance when it created $\begin{smallmatrix}6\\4\end{smallmatrix}$ chords. There were additional rules for prohibiting parallel perfect intervals between voices and other rules to govern the motion of voices from one chord to the next.

The second movement begins with the random orderings of 7-tone "white-note music." Successive constraints were applied in the course of the movement until four-part, note-against-note counterpoint was achieved at the end. Movement three includes all twelve tones, as well as greater rhythmic complexity and variety. The pitch and rhythm of this movement were each chosen by means of separate selection processes. The pitch material ranges from random chromatic music to twelve-tone rows. The initial rhythmic scheme for each instrument involves random selection of notes and rests within the measure, followed by random selections for the number of repetitions of the rhythm of each measure.

In the last movement the rules that control the probability of occurrence of an event in each stage of the music are even further removed from the stylistic criteria of traditional composition. Hiller and Isaacson employed Markov chains in the design of these rules. In their “Markov Chain Music," the composers created “sequences of events in which the choice of each new event can be made dependent on previous event ; or in musical terms, the choice of each note or interval in a given melodic line can be dependant upon previous notes or intervals in the same melodic line.”

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Example of Markov chain :

A transition table for generating a simple melody from four pitches

		last pitch C	D	E	G
next pitch	C	0.0	0.3	0.0	0.0
	D	1.0	0.3	0.3	0.0
	E	0.0	0.4	0.6	0.5
	G	0.0	0.0	0.1	0.5

Lejaren Hiller Quartet No. 4 for Strings "Illiac Suite" (1957)

composed in collaboration with Leonard Isaacson

I. Experiment One (Presto, Andante; Allegro)
II. Experiment Two (Adagio, ma non troppo Lento)
III. Experiment Three (Allegro con Brio)
IV. Experiment Four (Tanto Presto che possibile)

The Illiac Suite, which I decided some years ago to list in its chronological place in the set of seven string quartets I have written up through 1979, was composed in close collaboration with Leonard Isaacson, who was at the time of this work a research assistant in physical chemistry at the University of Illinois.

The Illiac Suite is a chronological record of experiments carried out from 1955 to 1957 to determine whether automatic electronic digital computers such as ILLIAC I, then located at the University of Illinois, can be used to generate music subject only to general instructions derived from logical compositional procedures. It is divided into the four movements listed above which illustrate how various specific musical problems were handled during this research. The contents of this quartet were taken from a much larger body of results by unbiased sampling procedures so that a representative rather than a selectively chosen musically superior group of results would be presented. Thus the quartet was meant to be a research record - a laboratory notebook. Whatever aesthetic unity it might have is entirely incidental to its primary reasons for existence.

The Illiac Suite was the first significant experiment in computer music and has since been followed by a number of other such experiments both in this country and in Europe. At the University of Illinois, its immediate successor was the Computer Contata of 1963, a piece of music that also included electronic sound synthesis by means of the CSX-l computer. The Illiac Suite, however, was written strictly for performance by string quartet. Among other things, computer sound synthesis had not been realized technically at the time of its completion.

In Experiment One, the primary purpose was to generate a recognizable form of polyphonic music simply to demonstrate that the technical problem can be handled. Simplified four-part first-species strict counterpoint was employed for this purpose. The successive sections of this movement demonstrate how the technique of composition was elaborated from monody to two-part to four-part writing.

In Experiment Two, the complete and correct solution to first-species counterpoint was achieved to demonstrate that a conventional form of music can be handled by computer logic. In this movement, there is first heard purely random white-note music. Then to this, rules are added which impose order until at the end of the movement, correct counterpoint is obtained.

In Experiment Three, problems of rhythm, dynamics and playing instructions are investigated in a texture of freely dissonant chromatic writing. The pitch choices are at first quite random but later controlled first by some simple rules of composition and still later by elementary twelve-tone serial procedures.

In Experiment Four, stochastic or probability music was generated. Although this is the most abstruse method of composition employed with the computer, it also seems the most logical technique for further developments in computer composition. It is the compositional technique most suited to and most dependent upon high-speed mathematical techniques.

My co-composer and I have published a full account of how these experiments were carried out (Lejaren Hiller and Leonard Isaacson' Experimental Music, McGraw-Hill Book Co., New York, 1959).

Duration : 18 minutes.
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First Performance: Aug. 9, 1956 ; Urbana, Ill., Peggy Andrix,
Sanford Renning (vlns.), George Andrix (vla.), Robert Swenson (vc.).
Recording : University of Illinois Composition String Quartet, Heliodor HS-25053 (currently out-of-print).