Composition as an Evolving Entity: an Experiment in Progress

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Background

Composing involves balancing different structural levels. Adjustments occur over long periods of time (Beethoven) even after publishing the work (Ives).

Manifolds

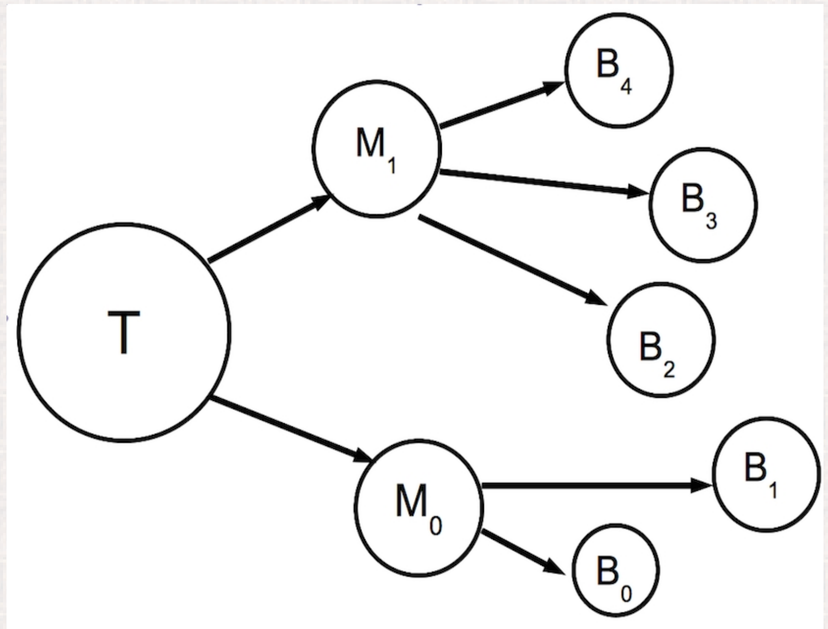
Composition (equivalence) classes involving randomness at all levels from the formal design to sound design. Same structure and same process produces different variants. Similar to faces in a crowd.

DISSCO

Digital Instrument for Sound Synthesis and Composition
An integrated environment, it has three parts: a Composition Module (CMOD), a Library for Additive Sound Synthesis (LASS) and LASSIE, an interface.DISSCO is comprehensive, a "black box" - the user does not intervene once it starts running, no post-production is necessary.

Directed Graphs

CMOD is a DG rooted tree where every level inherits from a generic Event class in a *matryoshka:* Top<High<Medium<Low<Bottom . Vertices are Events connected by weighted edges that illustrate the relationships between them.



This can accommodate both the stricter order found in traditional music (piece < sections < themes < motives < cells < sounds), random distribution of undifferentiated events (sounds in Cage's chance music works) or "floating hierarchies" as described by Herbert Brün.

COMPLEX DYNAMIC SYSTEMS - the "Brewing Piece"

All compositions are Complex Systems; they are also Dynamic during the act of composing since options are constantly re-evaluated. Evolving Entity project allows the computations to continue for an arbitrary amount of time. A work in perpetual transformation, never reaching an equilibrium, a complex structure whose components permanently fluctuate and adjust to each other's modifications in a series of unstable states.

The view of the composition as a network of perpetually unfolding elements in search of an elusive balance, similar to a living creature, epitomizes an "organic" approach to the creation of music.

The process never produces a definitive version but provides at any arbitrary point in time a plausible variant of the work - a transitory being. It is predicated on discovering and creating **new situations** as opposed to attaining known, already **established goals**: a volatile equilibrium and **NOT** a search for a stable optimal solution.

Composition as an Evolving Entity is an augmentation and a corollary of the *manifold* idea as they both generate an unlimited number of variants, involve the presence of randomness at all structural levels, and relay on the view of sounds as events in a multidimensional vector space whose degrees of freedom include time/duration, frequency, amplitude, etc.

Trivial Case

Evolving Entity allows computations to continue after the first *manifold* variant is completed: a new edge is created between the last Bottom event $\mathbf{X}_{last}$, (a terminal vertex) and another vertex $\mathbf{X}_{new}$ which could be a sibling, a parent or an ancestor belonging to the same branch or to a different one. The operation takes place with the help of an all-incidence matrix $\mathcal{M}$.

	T	**M_0**	**M_1**	**B_0**	**B_1**	**B_2**	**B_3**	**B_4**
T	0.01	0.05	0.05	0.02	0.01	0.03	0.03	0.01
M_0	0.20	0.01	0.25	0.20	0.20	0.05	0.10	0.07
M_1	0.20	0.01	0.01	0.11	0.10	0.25	0.20	0.23
B_0	0.12	0.20	0.11	0.01	0.30	0.19	0.08	0.07
B_1	0.12	0.24	0.10	0.35	0.01	0.07	0.08	0.09
B_2	0.12	0.06	0.15	0.10	0.12	0.01	0.26	0.26
B_3	0.12	0.08	0.18	0.11	0.14	0.25	0.01	0.26
B_4	0.11	0.06	0.15	0.11	0.12	0.25	0.24	0.01

This transitional matrix serves as a template for the Evolving Entity, a sort of ***genome*** of the composition.

Developing Entity

If the DG rooted tree DISSCO and the matrix $\mathcal{M}$ are NOT kept constant, the computations may start with a min number of vertices. Their number could grow to a maximum during subsequent variants then branches of the tree can be cut off gradually reducing the size of the matrix and leading to he demise of the Entity.

Template modification

Modifications of the template/genome could be introduced as computations continue. If the column vector $\mathbf{V}_{last}$ is multiplied by the matrix $\mathcal{M}$, $\mathbf{V}_{last} * \mathcal{M}$, every time a new variant of the piece completes, a Markov chain mechanism is initiated, an ordered sequence of causally connected vectors. This allows the system to evolve in predictable ways but assumes that the content of the matrix remains the same.

More realistically, global changes that occur when a new variant is produced need to be considered - something a human composer would certainly do. Such adjustments can be handled using

Information Theory

The main concepts as applied to musical messages are

- Entropy/Order expressed by the relationship between
  Originality → improbability, Information delivered and
  Redundancy → repetition, familiarity
- Complexity → number of available choices

Implementation

Trivial Case was implemented by connecting the last Bottom event to the Top event without interrupting the sequence of random numbers. *Sound Fountai*n, an installation producing continuous sound output in a local building's atrium is being developed. The project runs in multithreading mode and has been ported to a multicore system. DISSCO was conceived as a "Rolls Royce bulldozer": refined control over a large number of elements. Computing time depends heavily on the complexity of sounds their duration. Using a 16 CPU cores,a six min. stereo piece ran in less then five minutes while a more complex eight channel work of 12 min. took 17 min. A meaningful functioning of the system requires though a consistent ratio of 1/1 or faster between computation time and the duration of the piece (real time).

Future Work

This is an experiment in progress in its incipient stage. Conceptually, the project is situated at the intersection of Dynamic Systems Theory, Graph Theory and Information Theory relying on high-performance computing. A solid, practical link between these areas needs to be formulated.

Profiling, optimizing and parallelizing the code are urgent tasks and work is scheduled to begin at the San Diego Supercomputer Center through an Extreme Science and Engineering Discovery Environment (XSEDE). This will expand on the effort supported by Dr. Volodymyr Kindratenko and the Innovative Systems Laboratory at NCSA (National Cnter for Supercomputer Applications.

Conclusions

This is an original paradigm in Computer-assisted (Algorithmic) Composition. To our knowledge, no mechanism generating an evolving composition as a result of uninterrupted computations has been proposed before.

The Emerging Entity composition model is closer to how humans actually compose, by trial and error, continuously refining the output. It also reflects the natural world by creating the equivalent of a live organism, growing, developing, transforming itself over time and thus fulfilling the goal expressed by John Cage: "to imitate nature in its mode of operation".