Graph Theory and the Virtual Composer Residency Project

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Abstract: The Virtual Composer Residency Project is a series of works which link the creative music-making activities of web site visitors to the dynamic generation of an instrumental score for live concert performance. The project uses visual interfaces for the manipulation of musical structure in order to connect non-musicians directly to the compositional process, addressing many of the frustrations of more traditional composer-in-residence outreach programs. This paper presents historical background and key motivations for the project, and then describes Graph Theory for solo violin, the first work in the series.

1 Introduction

The Virtual Composer Residency Project is a series of works which link the creative music-making activities of web site visitors to the dynamic generation of an instrumental score for live concert performance. Visual interfaces for the explorations and manipulation of musical structure enable non-musicians to easily contribute to the compositional process.

Graph Theory, the first work in the project, enables web site visitors to navigate among sixty-one short, looping musical fragments to create their own unique path through the composition. Before each concert performance, the violinist prints out a copy of the score from the web site, which is algorithmically generated from user decisions.

2 Motivations and Goals

Composer residencies can include a diverse range of activities, from a composer giving a brief talk before the performance of his work to a multi-year partnership involving several commissions and a variety of educational and community outreach programs. But no matter the scope, the goal is usually similar: to make a composer, his music, and the process of composition more accessible to a community, and to raise awareness of and engagement with the music of living composers. The composer, too, should benefit from the experience, using the residency as an opportunity to gain new perspectives, hear new ideas, and create new work.

I had these goals in mind in 2001, when I was commissioned to write a piece for an elementary school band, chorus, and orchestra at the Collegiate School in Richmond, Virginia [Freeman 2001]. During a two-day residency, I met with large groups of students to present my work and solicit ideas. By actively involving them in my compositional process, I hoped that they would be motivated to listen for the realization of their ideas, and that they would share the excitement of writing a piece of music.

My naïve approach had limited success. I simply asked: "What ideas do you have for the piece?" While there was never a shortage of ideas, they were not particularly helpful. Most were hopelessly vague (e.g. loud, soft, fast, slow) or extramusical (e.g. animals, stories). In the end, the students were delighted that they had helped me to write the piece, but I felt like I had cheated them out of a truly meaningful contribution.

Similar challenges face many composers-in-residence. Musical scholars often struggle to effectively describe music through language. For a lay public without knowledge of a specialized vocabulary, the task is even more difficult, so discussion turns toward vague generalities and extramusical elements.

The Virtual Composer Residency Project attempts to capitalize on the excitement of my experience in Virginia while addressing some of its frustrations. Visual interfaces make it easier for participants to engage with abstract musical ideas, since they need not resort to language. The availability of these interfaces on the Internet makes them more accessible to a broader public, with lower barriers of time and cost to participation. And participation is not time-limited; these projects continually update the

performance score based on the activities of participants. While there are concert performances, there is never a final product; the score is always evolving.

3 Background

Numerous recent projects have explored collaborative, networked musical performance in real-time, ranging from the *NinJam* software architecture [Cockos 2005] to the collaborative *WebDrum* drum machine [Burk 1999] — which are in turn indebted to earlier analog works such as the *Radio Net* telephone call-in performance [Neuhaus 1994] and *Imaginary Landscapes No. 4* for twelve radios [Cage 1960].

This project, however, is inspired more by recent collaborative, networked projects in which participants interact with each other out of real time, contributing to the ongoing evolution of creative content. The *Collaborative Composition Website* [NYME 2005] presents a clear, if limited, musical implementation of this idea. Splice Music [Splice 2006] creates a multi-track audio interface for collaborative remixes and collages built from shared sound libraries. And in the visual realm, *SwarmSketch* [Edmunds 2005] creates a structured environment for collaborative drawing, and *SodaPlay* [Soda 2003] enables users to modify and transform each other's robot-like constructions.

The Virtual Composer Residency Project also draws from a tradition of dynamically generated scores that change their visual appearance from one performance to the next. In *Calder Piece* [Brown 1966], the music, which is part of a sculpture, literally moves. And more recent projects render digital scores in real-time based on the activities of musicians and/or audience members [Clay 2006] [Kim-Boyle 2006].

4 Graph Theory

Graph Theory, the first piece in the Virtual Composer Residency Project, draws on Stockhausen's moment form [Kramer 1978], the graph structures common in computer science and discrete mathematics, and the hypertextual narrative structure of the web itself. Participants navigate through a series of sixty-one looping musical fragments for solo violin, which they see in a visual piano-roll notation and hear as audio

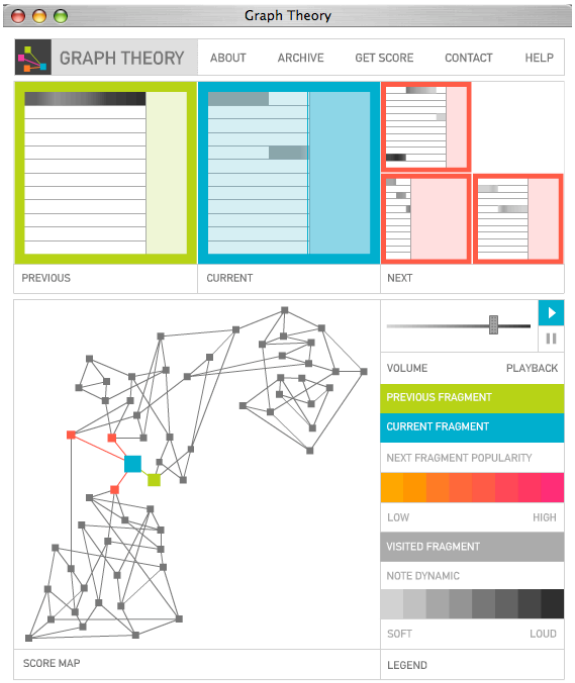

Figure 1: Graph Theory Web Interface.

recordings. But their navigational decisions are constrained by the work's graph structure, in which each fragment is directly linked to only three or four other fragments on the graph. (These links were created intuitively during the composition of the music.) The web interface (Figure 1), which was created in Flash, also shows users their current location within the entire graph structure, tracks which fragments they have visited, and enables them to review the path they have followed thus far.

As users navigate through the musical fragments, each decision they make is logged on a server-side MySQL database. The server also records the number of times a fragment loops before a new decision is made. Each day, then, the server regenerates the PDF score files for the piece (for solo violin and solo cello, respectively), which can be downloaded from the web site for use in concert performances.

The algorithm, implemented in PHP, generates a linear path through the composition. It first assigns weights to the edges linking each pair of fragments in the graph; the more "votes" a particular edge has received from participants, the lower its weight. The software then finds the path that visits all fragments at least once but has the lowest total weight, solving this optimization

as a variation of the traveling salesman problem (and using a genetic algorithm to do so). In this manner, more popular path segments are more likely to appear in performance scores. The score also instructs the performer to repeat each fragment; the number of repetitions is based on the average number of times online participants let the fragment loop before moving on.

4 Conclusion

Graph Theory is a simple, initial step towards realizing the goals of the Virtual Composer Residency Project. Future works in the project will explore more malleable musical structures, additional evolutionary strategies, and larger performing forces.

4 Acknowledgements

Graph Theory is a 2005 commission of New Radio and Performing Arts, Inc., (aka Ether Ore) for its Turbulence web site. It was made possible with funding from the Greenwall Foundation. Special thanks to my collaborators, designer Patricia Reed and violinist Maja Cerar, for their creative ideas, talent, and hard work. Graph Theory is available at http://turbulence.org/Works/graphtheory/.

References

[Brown 1966] Brown, E. 1966. *Calder Piece*. The Earle Brown Music Foundation, New York.

[Burk 1999] Burk, P. 1999. *WebDrum*. http://www.transjam.com/webdrum/.

[Cage 1960] Cage, J. 1960. *Imaginary Landscape No. 4*. Henmar Press, New York.

[Clay 2006] Clay, A. 2006. Conduct Yourself. *Proceedings of Digital Art Weeks*, ETH Zurich.

[Cockos 2005] Cockos Incorporated. 2005. *NinJam*. http://www.ninjam.com.

[Edmunds 2005] Edmunds, P. 2005. *SwarmSketch*. http://www.swarmsketch.com/.

[Freeman 2001] Freeman, J. 2001. *The Jungle Book*. Self-published score. Available at http://www.jasonfreeman.net.

[Kim-Boyle 2006] Kim-Boyle, D. 2006. Real Time Generation of Open Form Scores. *Proceedings of Digital Art Weeks*, ETH Zurich.

[Kramer 1978] Kramer, J. 1978. Moment Form in Twentieth Century Music. *The Musical Quarterly* 64.

[Neuhaus 1994] Neuhaus, M. 1994. The Broadcast Works and Audium. In *Zeitgleich*. Vienna: Triton. http://auracle.org/docs/Neuhaus_Networks.pdf.

[NYME 2005] New York Miniaturist Ensemble. 2005. *Collaborative Composition Website*. http://nyme.org/collaborative.html.

[Soda 2003] Soda. 2003. *SodaPlay*. http://www.sodaplay.com.

[Splice 2006] Splice, Inc. 2006. *SpliceMusic*. http://www.splicemusic.com.