

Musical Variations from a Chaotic Mapping

Diana S. Dabby presents a novel approach for generating similar musical variations from a given original piece. Her approach is based on the use of Lorenz equations that describe chaotic behavior. The variations can be made to be as close or different to the original as desired based on the initial conditions input to the system. The output is then intended to be used as is or as inspiration in the development of new ideas.

The Lorenz equations are intended to describe systems in which the final progression or sequence of events is highly dependent on its initial conditions. For example a double pendulum, where one pendulum is placed at the base of another) is a typical type of chaotic system. When the arm of a single pendulum is placed x degrees from the vertical axis the motion it exhibits is nearly identical to the motion of a pendulum placed $x + .01$ degrees. However after only a short period of time the motions of two double pendulum systems quickly diverge in behavior. Although the behavior neither forms a steady state, nor periodic motion the behavior is not actually random even though it appears to be at first.

Dabby's idea is to use the same pitches from the original piece but vary them based on Lorenz equations so that the new piece remains reminiscent of the original regardless of the initial conditions. However, if the initial conditions are close and the other parameters are set appropriately then the new piece will greatly overlap and only vary slightly. Since the behavior described by these equations causes variations to happen quite quickly in time a few other modifications had to be made to keep the new pieces from becoming discernible. First the function that mapped x values to pitches in the original piece allowed nearby trajectories to map to the same pitch provided the x components were both in the same pitch dominion. Also x values were rounded to two decimal places other wise every component would be unique and no variation would occur.

To demonstrate the results several variations of the prelude to Bach's piece *The Well-Tempered Clavier* were generated. The third variation introduced some issues in that some x values exceed all valid values and so no pitches were able to be assigned. This highlighted the fact that these variations were envisioned as an aid to composers and not an end to themselves so a person could easily fill in these missing pieces themselves. The third variation was also used to show how these generations could be used as a brainstorming tool. Several musical ideas were produced by the variation but each would need human intervention to fully develop the idea into a complete piece. *Variations to a Theme* is another example from the paper of how variations can be used for more contemporary music. The variation technique was used to produce several variations which the composer then modified to suit the entire piece as they felt best worked. Additionally this led to the idea of variations in performance in which the piece varied slightly each time it was performed but was distinctly recognizable each time. Although for all the pieces discussed in this paper Lorenz equations of one dimension, the pitch, were used Dabby also discussed the

possibility for using higher dimensions to capture variations in rhythm or volume as well. Several other ideas were also presented such as using other variations of Lorenz equations or concatenating and splicing pieces together to produce different pitch sets.