Global Dynamics Approach to Generative Music Experiments with One Dimensional Cellular Automata

Dave Burraston and Ernest Edmonds

Creativity and Cognition Studios (CCS), Faculty of Information Technology, University of Technology, Sydney, Australia.
E-mail: dave@noyzelab.com, ernest@ernestedmonds.com

Abstract

One Dimensional Cellular Automata (CA) offer the use of emergent computation and behaviours as compositional aids to the generative music process. Global dynamics and rule clustering are important concepts in CA research, and CA music research to date has not addressed these topics. Global dynamics and rule clusters offer a new perspective of CA based on the topology of attractor basins. A methodological approach is described as a foundation for future experimentation. Reflective practice techniques will be used as experimental method. Evaluation of results will be judged against recognised criteria. A one dimensional CA is chosen for a foundation experiment in generative music production and visualisations of this will be presented. This work will give CA based generative music a significant shift of context and awareness for the generative artist.

1 Introduction

Algorithmic and computational processes are an important tool for the technology based creative artist producing generative music [3]. CA offer the use of emergent computation and behaviours as compositional aids to the generative art process. CA have been utilised in a number of novel applications in MIDI based computer music [2]. Complexity theory demonstrates that complex systems of simple units, such as the cells in a CA, produce a variety of behaviours. Complex systems such as CA produce global behaviour based on the interactions of these simple units.

CA were conceived by Stanislaw Ulam and John von Neumann in an effort to study the process of reproduction and growths of form [1]. CA are dynamic systems in which time and space are discrete. They may have a number of dimensions, single linear arrays or two dimensional arrays of cells being the most common forms. The CA algorithm is a parallel process operating on this array of cells. Each cell can have one of a number of possible states, sometimes expressed as **k**. The simultaneous change of state of each cell is specified by a local transition rule. The local transition rule is applied to a specified neighbourhood around each cell, sometimes expressed as **r**. The number of cells is given as a number **L**.

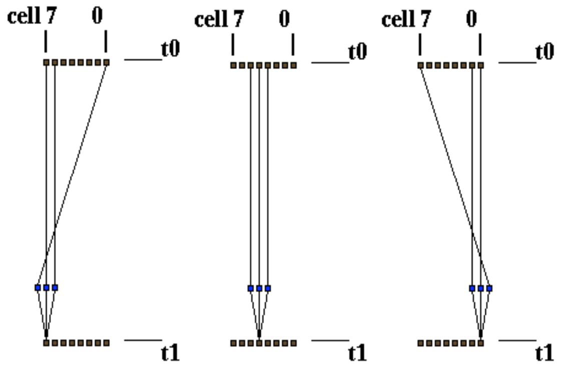

Figure 1. Wiring of periodic boundary cells (left and right) and cell 4 (centre) of an 8 cell (L=8) 1D CA.

CA are usually, but not always, infinite in length. Cells are commonly wrapped around at the edge of the array during the local transition rule computation, to achieve a conceptual infinite array. In this case the array is finite, but unbounded and is said to have periodic boundary conditions. One dimensional binary CA (**k=2, r=1**) have been classed by Wolfram with one of four behaviours [10] as shown in Table 1.

Class 1	**Class 2**	**Class 3**	**Class 4**
Patterns disappear or become fixed	Patterns evolve to periodic structures	Patterns become chaotic	Patterns grow into complex forms.

Table 1. Wolfram's CA behaviour classes.

The wiring for the edge cells and cell 4 of an 8 cell 1D CA is shown in Fig. 1. Here we can see two time steps of the system from **t0** to **t1**. The transition rule is specified by an 8 bit binary number between 0 and 255 and an example for rule 110 is shown in Fig. 2. The 8 entries in a rule transition table are defined as **T7** to **T0** left to right.

Proceedings ACMC 2004
ISSN: 1448-7780
http://acma.asn.au