Chapter 22. Meeting 22, Approaches: Agents and Ecological Models

22.1. Announcements

• Sonic system reports due and presentations begin: 11 May
• Last quiz: Tuesday, 4 May

22.2. Workshop: Sonic System Project Drafts

• Last two students present their draft projects

22.3. Agents

• Software models of autonomous sub-systems
• Complexity and emergent behavior through the interaction of simple agents

22.4. Interactive Music Systems

• Computers that musically respond to MIDI messages (control data)
• Computers that musically respond to audio (sound through a microphone)
• Computers that accompany a human performance based on a shared score
• Computer (agents) that musically respond to each other (via audio or MIDI)

22.5. Analysis and Generation

• Interactive systems must have two basic components
• Components that “listen” to control data or audio information, and decode into musical models
• Components that generate musical responses based on analysis

22.6. Interactivity: Theatre

• Musical performance is theatre
• Appeal of technological achievement or drama of technological disaster

22.7. Applications of Multi-Parameter Feature Extraction

• Detect articulation, pitch, and tempo and match to a score: score following
• Detect articulation, pitch, and rhythms, and build musical responses: interactive systems, installations

22.8. Multi-Parameter Feature Analysis in PD

• [fiddle~] object: pitch, event, and amplitude

22.9. Early Historical Examples of Interactive Music Systems

• 1967: Gordon Mumma’s *Hornpipe* (1967): “an interactive live electronic work for solo hornists, cybersonic console, and a performance space”; system analyzes sound form horn and in performance space
• 1968: Max Mathews and F. Richard Moore develop GROOVE system at Bell Labs. Real-time performance interface to a predetermined musical score

• 1979: George Lewis, with a KIM-1 computer, develops interactive compositions designed to work with improvisation

• 1983: Felix Hess creates 40 *Electronic Sound Creatures*, small mobile machines with microphones and speakers that respond to each other and the environment

• 1987: Robert Rowe develops a system called Cypher, consisting of a Listener, a Player, and a Critic, used in *Flood Gate* (1989)
22.10. Reading: Rowe: Machine Listening and Composing with Cypher

- What types of features are extracted during the first level of listener analysis?
- What types of features are extracted during the second level of analysis?
- How does the chord and key analysis routines work?
- What are the three compositional methods employed?
- What is the role of the critic?
- How is the large-scale behavior of the system varied over time?

22.11. Listening: Rowe

- Listening: Robert Rowe, *Shells*, 1993

22.12. Listening: Ariza

- Listening: Christopher Ariza, *to leave the best untold*, 2009

22.13. Alternative Agent Models

- Analogies to human roles
- Analogies to ecological models
- Analogies to social systems
- Analogies to physical systems


- Particles in a dynamic system
- Particles
  - Have one or more states, each state with a discrete life span
  - Particle expired at termination of life span
  - Life cycle:
    ```
    [('a', 1), ('b', 2)]
    ```
- Particle Transformers
  - Have one or more states, each state with a discrete life span
  - Particle expired at termination of life span
  - State determines focus of particle
  - Focus is target state looked for in other particles; transformed with transformation map
  - Transform map:
    ```
    {'a': [(None, 3), ('a', 1)]}
    ```
  - Related to first order Markov chain
- Sensor Producers
  - Produces one type of Particle
  - Produces one type of Particle Transformer
  - Stores a threshold, a target value for a given state
  - Senses the composition of a collection of Particles
  - Stores a production count range: given difference from threshold, give a range of Particles to produce (when below threshold) or Particle Transformers to produce (when above threshold).
  - Production count range:
    ```
    {(-30, -10): [1, 2], (1, 10): [1, 2], (11, 20): [1, 4], None: [1, 8]}
    ```
- Environment
  - Store lists of Sensor Producers, Particles, and Particle Transformers
  - Provides model of Sensor Producer (one for now)
  - Provides an absolute discrete value range for sensed particle
• Specify number of sensors
• Can age all Particles by one or more age steps

22.15. Feedback System as ParameterObject

• The feedbackModelLibrary ParameterObject

:: tpv fml
Generator ParameterObject
{name,documentation}
FeedbackModelLibrary feedbackModelLibrary, feedbackModelName, parameterObject, parameterObject, min, max
Description: Produces values from a one-dimensional string rewrite rule, or Lindenmayer-system generative grammar. The terminus, or final result of the number of generations of values specified by the stepCount parameter, is used to produce a list of defined values. Values are chosen from this list using the selector specified by the selectionString argument. Arguments: (1) name, (2) feedbackModelName, (3) parameterObject {aging step}, (4) parameterObject {threshold}, (5) min, (6) max

• A basic model of a Thermostat: particles as heat

:: tpmap 100 fml,t,(bg,rc,(1,1.5,2))
feedbackModelLibrary, thermostat, (basketGen, randomChoice, (1,1.5,2)), (constant, 0.9), (constant, 0), (constant, 1)
TPmap display complete.

• Dynamic age values applied to Particles

:: tpmap 100 fml,t,(ls,e,(c,30),0,4)
feedbackModelLibrary, thermostat, (lineSegment, (constant, 30), (constant, 0), (constant, 4)), (constant, 0.9), (constant, 0), (constant, 1)
TPmap display complete.
• Climate control: produce both Particles and Particle Transformers

:: tpmap 100.fml,cc,(bg,rc,(.5,1,1.5))
feedbackModelLibrary, climateControl, (basketGen, randomChoice, (0.5,1,1.5)),
(constant, 0.9), (constant, 0), (constant, 1)
TPmap display complete.

• Alternative approaches to PO interface?

22.16. Feedback System as Dynamic Contour

• Can treat the grammar alphabet as parameter values: integers, floating point values

• Command sequence:

  • emo mp
  • tmo lg
  • tin a 66
  • constant pulse
    tie r pt,(c,8),(c,1),(c,1)
  • amplitude controlled by Thermostat feedback
    tie a fml,t,(bg,rc,(1,1.5,2))
  • using convert second to set durations
tie r cs,(fml,t,(c,1),(c,.7),.001,.400)

• amplitude controlled by Climate Control feedback
  
tie a fml,cc,(bg,rc,((.5,1,1.5)),(c,.7),0,1

• eln; elh

22.17. Feedback System as Path Index Values

• Feedback system states as index values from the Path

• Command sequence:
  
• emo m
  
• create a single, large Multiset using a sieve

  pin a 5@1|7@4,c2,c7

• tmo ha

• tin a 107
  
• constant rhythm

  tie r pt,(c,4),(c,1),(c,1)

• select only Multiset 0

  tie d0 c,0

• create only 1 simultaneity from each multiset; create only 1-element simultaneities

  tie d2 c,1; tie d3 c,1

• select pitches from Multiset using Thermostat

  tie d1 fml,t,(bg,rc,((1,1.5,2)),(c,.7),0,18

• select pitches from Multiset using Climate Control

  tie d1 fml,cc,(bg,rc,((.5,1,1.5)),(c,.7),0,18

• eln; elh