Chapter 1. Meeting 1, Foundations: Algorithmic and Generative Music Systems

1.1. Announcements

- 21M.380: Music Technology: Algorithmic and Generative Music Systems

1.2. Overview

- The last 10 years of algorithmic and generative music systems
- What are algorithmic and generative music systems?
- Two examples
- About this course

1.3. Generative Systems: Definitions

- Machines that make music
- Humans that use or make machines to make music
- Humans that use or make machines to help them make music
- Humans that use or make machines to help them make components of their music

1.4. A New Field of Compositional Research

- Generative music with a computer took many names:
  - Algorithmic composition
  - Computer music
  - Score synthesis
  - Computer-aided (or -assisted) composition
- Computer-aided algorithmic composition (CAAC)
- A new type of generative (rather than reductive) music theory

1.5. Computer-Aided Algorithmic Composition: Definition

- A negative definition
- A CAAC system is software that facilitates the generation of new music by means other than the manipulation of a direct music representation (Ariza 2005b)
- New music: a unique musical variant, not just as copy
- Output may be in the form of any sound or sound parameter data, from a sequence of samples to the notation of a complete composition
- A "direct music representation" refers to a linear, literal, or symbolic representation of complete musical events, such as an event list (a score in Western notation or a MIDI file) or an ordered list of amplitude values (a digital audio file or stream)
- If the representation provided to the user is the same as the output, the representation may reasonably be considered direct.
- Anything that is not a direct representation employs CAAC

1.6. A Wide Range of Interactions and Collaborations

- Machines can be used to create complete structucres
- Machines can be used to create small fragments that are manually integrated
- Machines can be used to create guidelines, contexts, or situations for human music making

1.7. Two Examples

- I: Minuets and Contredances
- II: babelcast

1.8. I: Minuets and Contredances

- Minuet: a French dance in moderate triple meter, popular in aristocratic society from mid 17th century to late 18th century (Grove Music Online)
- Textbook composition method: two or four bar groups, each section being 8 or 16 bars long
- Audio played in class: Bach: Minuet in G, MWV Anh 114

- Audio played in class: Mozart: Minuet in G, K. 1

1.9. I: Minutes and Contredances: Musical Dice Games

- 1757-1812: at least 20 musical dices games published (Kirnberger, CPE Bach, J Haydn, Mozart, others)
- Musical composition game, one of many 18th-century parlor games (Hedges 1978, p. 180)
- A table is used to translate the sum of two dice to appropriate score positions
- Score positions specify complete measure-length segments for each possible phrase position
- German composer Kirnberger published one of the first in 1757

Tabelle der Würffe zu Polonoisen

Zum ersten Theil

Theil seines Würffels	1.	2.	3	4.	5.	6	.	.	.	.	.
Theil seines Würffels	2	3	4	5	6	7	8	9	10	11	12
Der 1 Zug	70	10	42	62	44	72	114	123	131	138	142
Der 2 Zug	34	24	6	8	56	30	112	116	147	151	153
3 Zug	68	50	60	36	40	4	126	137	143	118	146
4 Zug	18	46	2	12	79	28	87	110	113	124	128
5 Zug	32	14	52	16	118	22	89	91	107	141	150
6 Zug	58	26	66	38	54	64	88	98	115	127	134

Zum zweyten Theil.

Theil seines Würffels	1	2	3	4.	5	6	.	.	.	.	.
Theil seines Würffels											
Der 1 Zug	80	20	82	43	78	69	90	129	103	143	152
2 Zug	11	77	2	41	84	62	92	99	140	149	102
3 Zug	59	65	9	45	29	7	86	107	111	97	135
4 Zug	35	5	83	17	75	47	94	122	145	134	148
5 Zug	74	24	67	37	63	19	96	105	133	120	136
6 Zug	10	71	1	49	57	21	85	92	109	102	108
7 Zug	21	15	53	72	51	81	95	106	117	119	130
8 Zug	33	39	25	23	76	55	104	121	125	132	139


Polonoise
Violino primo
Violino secundo
Clavier
Basso

- Numerous versions of *Musikalisches Würfelspiel* attributed to Mozart
- The version attributed to Mozart was first published two years after his death by Juhan Julius Hummel (1793) and includes two similar games: one for Minuets and another for contredances
- Two 8-bar phrases are created from combining 176 pre-composed measures
- The last bar of each phrase always uses the same measure

1.10. I: Minuets and Contredances: The First Computer Implementation

- 1955: David Caplin and Dietrich Prinz write a program to generate and synthesize the Mozart Dice Game for contredances on a Ferranti Mark 1* (MIRACLE) at Shell laboratories in Amsterdam (Ariza 2010)
- Likely the first use of a computer to generate music
- Ferranti Mark 1* (MIRACLE)

Audio sample played in class.

1.11. I: Minutes and Contredances: Motivations and Meanings

- Why do this? How is this possible?
- Is new music being made?
- What meaning, if any, is conveyed?

1.12. II: The babelcast

- An algorithmic, computer generated podcast series (Ariza 2007b)

  Audio RSS URL: (http://www.flexatone.net/babelcast.xml)

  Video RSS URL: (http://www.flexatone.net/babelcast-zoetrope.xml)
- First released 5 August 2005, around one episode a month since
- Created with athenaCL, Python, and Csound
- Distributed in three formats: mp3, (-mosaic) m4a, and (-zoetrope) m4v

1.13. II: The babelcast: Information Abduction and Reduction

- Gather sounds of politicians and political commentators
- Gather images of politicians and political commentators
- Favor primary sources
- Favor massively redundant surplus media: images and sounds that are obtained by many sources

1.14. II: The babelcast: The Process

- Sounds are manually collected with minimal editing
- images are automatically downloaded and then manually filtered
- Around 40 Texture-generating procedures for athenaCL are configured for each episode
  - Some Textures create noises

    - Some Textures process samples
    - Csound instruments use vocoders, granular synthesis methods, and other techniques
- Between 100 and 200 Textures are generated and mixed into a single audio file
- Images are randomly selected, cropped, and zoomed

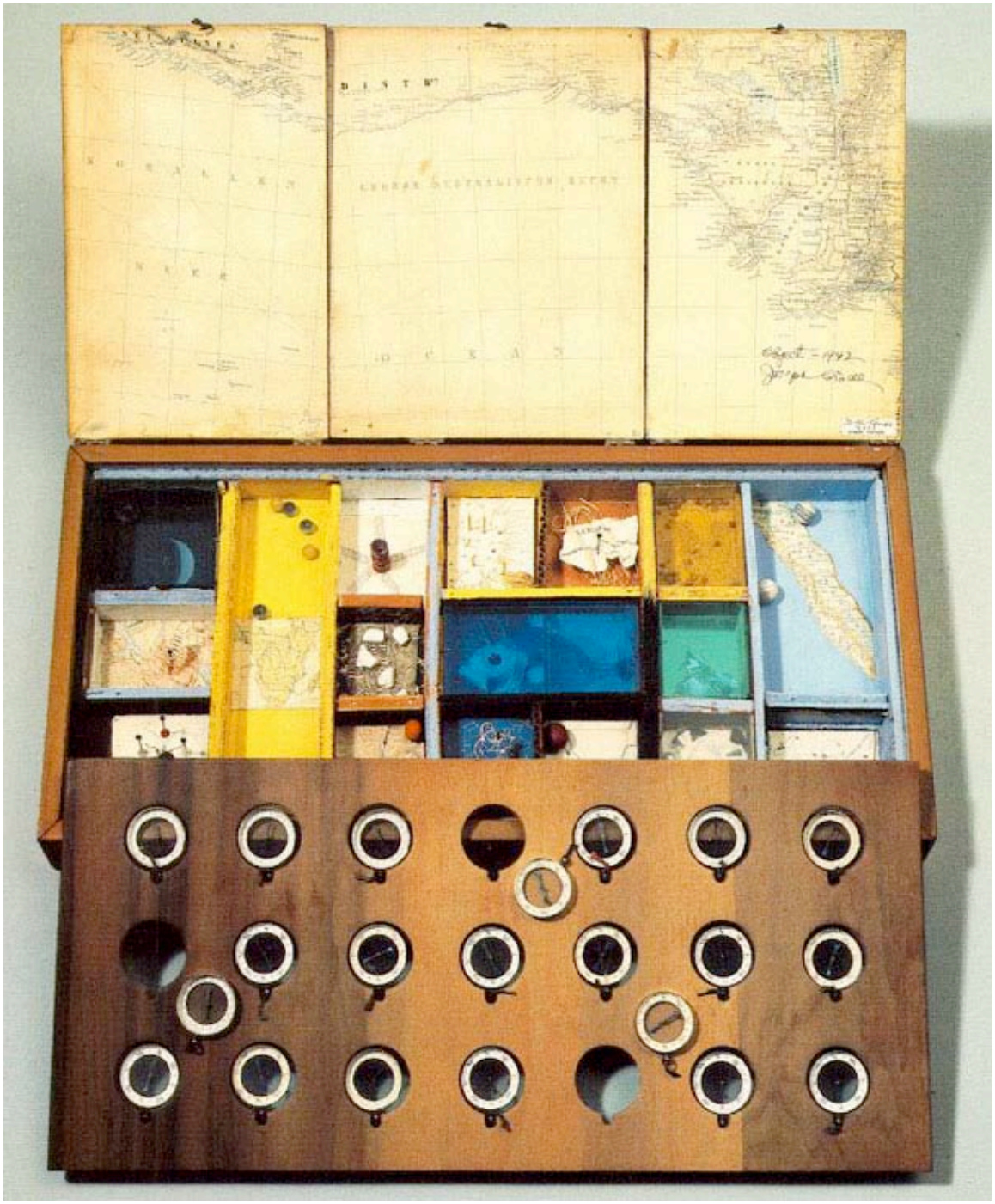
1.15. II: Listening

- babelcast-zoetrope-2009.12.27

(http://www.flexatone.net/video/m4v/babelcast-zoetrope-2009.12.27.m4v)

1.16. II: The babelcast: Precedents

- 1989: Umberto Ecco, *The Open Work*
    - Leaving parts of a work to chance
    - Works that "reject the definitive, concluded message and multiply the formal possibilities of the distribution of their elements" (Eco 1989, p. 3).
- 1986: William Gibson, *Count Zero*
    - Artificial intelligence that sends randomly constructed human junk, found in space, back down to earth, which is assumed to be forged works of artists Joseph Cornell
    - American "assemblage" artist Joseph Cornell (1903-1972)
    - Cornell: *Object (Roses des Vents)* (1942-53)



1.17. II: The babelcast: Motivations and Meanings

- Why do this?
- What meaning, if any, is conveyed?

1.18. 21M.380: Objectives

- To gain a critical understanding of the history, techniques, and designs of algorithmic and generative music systems
- To develop musical creativity and expression in the use and design of algorithmic and generative music systems
- To critically evaluate claims of aesthetic and technological advancement, quality, and promise

1.19. 21M.380: Areas of Focus

- History: Mechanical Musical Automata, Serialism, Phasing, Gottfried Michael Koenig, Lejaren Hiller, Iannis Xenakis
- Approaches: Distributions and Stochastics, Probability and Markov Chains, Cellular Automata, Genetic Algorithms, Grammars and L-Systems, Agents and Ecological Models, Expert Systems and Style Emulation, Non-Standard Synthesis, Granular and Concatenative Synthesis, Mapping, Sonification, and Data Bending
- Workshops and Discussion

1.20. 21M.380: Prerequisites

- None but curiosity, willingness to experiment
- Programming in Python or other languages useful, but not required
- Experience with digital audio and DAW software desirable, but not required

1.21. 21M.380: Course Meetings and Materials

- Syllabus:
- Two types of meetings
  - Topic meetings: focused on material in readings, listening, and themes, combining lecture, discussion, demonstration, and listening
  - Workshop meetings: focus on discussion of projects and techniques, hands-on experimentation
  - If possible, bring laptops to all class meetings
- Software: core tools
  - athenaCL

    - Python
    - Csound
    - SuperCollider
    - PD
    - DAWs and virtual instruments
- Lecture notes

1.22. 21M.380: Assignments: Reading

- Numerous carefully selected readings

Ames, C. 1987. "Automated Composition in Retrospect: 1956-1986." *Leonardo* 20(2): 169-185.

Ames, C. 1992. "A Catalog of Sequence Generators: Accounting for Proximity, Pattern, Exclusion, Balance and/or Randomness." *Leonardo Music Journal* 2(1): 55-72.

Ames, C. 1991. "A Catalog of Statistical Distributions: Techniques for Transforming Random, Determinate and Chaotic Sequences." *Leonardo Music Journal* 1(1): 55-70.

Ames, C. 1989. "The Markov Process as a Compositional Model: A Survey and Tutorial." *Leonardo* 22(2): 175-187.

Ariza, C. 2007a. "Automata Bending: Applications of Dynamic Mutation and Dynamic Rules in Modular One-Dimensional Cellular Automata." *Computer Music Journal* 31(1): 29-49. Internet: http://www.mitpressjournals.org/doi/abs/10.1162/comj.2007.31.1.29.

Ariza, C. 2006. "Beyond the Transition Matrix: A Language-Independent, String-Based Input Notation for Incomplete, Multiple-Order, Static Markov Transition Values." Internet: http://www.flexatone.net/docs/btmimosmtv.pdf.

Ariza, C. 2009a. "The Interrogator as Critic: The Turing Test and the Evaluation of Generative Music Systems." *Computer Music Journal* 33(2): 48-70. Internet: http://www.mitpressjournals.org/doi/abs/10.1162/comj.2009.33.2.48.

Ariza, C. 2005b. "Navigating the Landscape of Computer-Aided Algorithmic Composition Systems: A Definition, Seven Descriptors, and a Lexicon of Systems and Research." In *Proceedings of the International Computer Music Conference*. San Francisco: International Computer Music Association. 765-772. Internet: http://www.flexatone.net/docs/nlcaacs.pdf.

Ariza, C. 2005c. "The Xenakis Sieve as Object: A New Model and a Complete Implementation." *Computer Music Journal* 29(2): 40-60. Internet: http://www.mitpressjournals.org/doi/abs/10.1162/0148926054094396.

Ben-Tal, O. and J. Berger. 2004. "Creative Aspects of Sonification." *Leonardo Music Journal* 37(3): 229-232.

Berg, P. 2009. "Composing Sound Structures with Rules." *Contemporary Music Review* 28(1): 75-87.

Biles, J. A. 2003. "GenJam in Perspective: A Tentative Taxonomy for GA Music and Art Systems." *Leonardo* 36(1): 43-45.

Cope, D. 1992. "Computer Modeling of Musical Intelligence in EMI." *Computer Music Journal* 16(2): 69-83.

Ebcioglu, K. 1988. "An Expert System for Harmonizing Four-part Chorales." *Computer Music Journal* 12(3): 43-51.

Hiller, L. and L. Isaacson. 1958. "Musical Composition with a High-Speed Digital Computer." *Journal of the Audio Engineering Society* 6(3): 154-160.

Hoffman, P. 2000. "A New GENDYN Program." *Computer Music Journal* 24(2): 31-38.

Koenig, G. M. 1971. "The Use of Computer Programs in Creating Music." In *Music and Technology (Proceedings of the Stockholm Meeting organized by UNESCO)*. Paris: La Revue Musicale. 93-115. Internet: http://www.koenigproject.nl/Computer_in_Creating_Music.pdf.

Koenig, G. M. 1983. "Aesthetic Integration of Computer-Composed Scores." *Computer Music Journal* 7(4): 27-32.

Magnus, C. 2004. "Evolving electroacoustic music: the application of genetic algorithms to time-domain waveforms." In *Proceedings of the International Computer Music Conference*. San Francisco: International Computer Music Association. 173-176.

Marino, G. and M. Serra, J. Raczinski. 1993. "The UPIC System: Origins and Innovations." *Perspectives of New Music* 31(1): 258-269.

Mason, S. and M. Saffle. 1994. "L-Systems, Melodies and Musical Structure." *Leonardo Music Journal* 4: 31-38.

Miranda, E. R. 2003. "On the Music of Emergent Behavior: What Can Evolutionary Computation Bring to the Musician?." *Leonardo* 36(1): 55-59.

Riskin, J. 2003. "The Defecating Duck, or, the Ambiguous Origins of Artificial Life." *Critical Inquiry* 29(4): 599-633.

Roads, C. 1988. "Introduction to Granular Synthesis." *Computer Music Journal* 12(2): 11-13.

Rowe, R. 1992. "Machine Listening and Composing with Cypher." *Computer Music Journal* 16(1): 43-63.

Serra, M. 1993. "Stochastic Composition and Stochastic Timbre: GENDY3 by Iannis Xenakis." *Perspectives of New Music* 31(1): 236-257.

Soldier, D. 2002. "Eine Kleine Naughtmusik: How Nefarious Nonartists Cleverly Imitate Music." *Leonardo Music Journal* 12: 53-58.

Sturm, B. L. 2006. "Adaptive Concatenative Sound Synthesis and Its Application to Micromontage Composition." *Computer Music Journal* 30(4): 46-66.

Voss, R. F. and J. Clarke. 1978. "1/f Noise in Music: Music from 1/f Noise." *Journal of the Acoustical Society of America* 63(1): 258-263.

Xenakis, I. 1971. "Free stochastic Music." In *Cybernetics, art and ideas*. J. Reichardt, ed. Greenwich: New York Graphic Society. 124-142.

Xenakis, I. 1987. "Xenakis on Xenakis." *Perspectives of New Music* 25(1-2): 16-63.

1.23. 21M.380: Assignments: Listening

- Reading notation and scores not required
- Take notes when you listen
- What to listen for: duration, instrumentation, method of production, recording or performance context, notable sonic events, form, temporal design and proportions, aesthetic or historical contexts, and/or critical and subjective responses

1.24. 21M.380: Assignments: Discussion Leaders

- Students are assigned to cover each reading and listening assignments for each class
- Must be available to lead discussion, answer questions, and provide a resource to class
- Must post minimal notes in the class website forum: Reading and Listening Notes

1.25. 21M.380: Assignments: Musical Design Report

- An original sonic sketch or musical work, lasting from two to five minutes, realized in notation, MIDI, digital audio, or code, and based on approaches, techniques, and/or models presented for each assignment
- Includes a very short written report describing approaches and design
- A group of 3 to 4 students will be selected to present their projects to the class during Workshop sessions
- Three spaced evenly throughout the semester

1.26. 21M.380: Assignments: Sonic System Project and Presentation

- An original sonic system that functions as either a generative instrument with or without a performance interface or as a static or dynamic musical work employing techniques and/or tools of algorithmic composition.
- May explore any software or hardware system or interface; can extend class examples or produce completely original works
- Includes a short written report describing approaches and design
- Draft workshop meeting: 27 April
- Final presentations: 11 and 13 May

1.27. 21M.380: Assignments: Submission

- All assignments are submitted digitally via email attachment (or as Forum posts)
- All assignments, except as noted, are due at 11:59:59 PM on due date
- Late within 1 week: 20% reduction; no assignments accepted after 1 week

1.28. 21M.380: Attendance

- Mandatory and essential
- More than one unexcused absence incurs a 3% grade reduction

1.29. 21M.380: Exams and Quizzes

- Quizzes will be announced, and frequent

- All short written answers
- Quizzes will be based on reading, listening, and course content
- No final exam

1.30. 21M.380: Grading

- Reading and Listening Discussion Leader: 20%
- Musical Design Report (3): 30%
- Sonic System Project and Presentation: 20%
- Sonic System Project Draft: 5%
- Quizzes: 15%
- Participation: 10%

1.31. 21M.380: Additional Policies

- Read entire syllabus
- Common courtesies
- Computers in class
- Academic integrity

1.32. 21M.380: Contact

- Always feel free to contact me with any problem or concern with this class

1.33. Us

- Backgrounds, experiences, goals

1.34. For Next Class

- Download and read entire syllabus
- Respond to my email questionnaire
- Bring computers

[pp. 17-19 deleted from these notes, due to privacy considerations]

21M.380 Music and Technology: Algorithmic and Generative Music
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