

AI Methods for Algorithmic Composition

A Survey, a Critical View and Future Prospects

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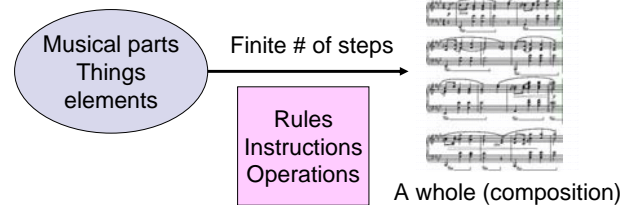
Outline

- Introduction – history
- The survey
 - Existing methods till 1999 in algorithmic composition.
 - Six categories.
 - Who are them?
- Discussion
 - Evaluation (how do the results sound?)
 - Knowledge representation
 - Computational creativity
- Prospects for the future



Introduction

- Definition of Algorithmic Composition (Cope, 1993)



- Mozart's Dice Game

<http://sunsite.univie.ac.at/Mozart/dice>



First computational model

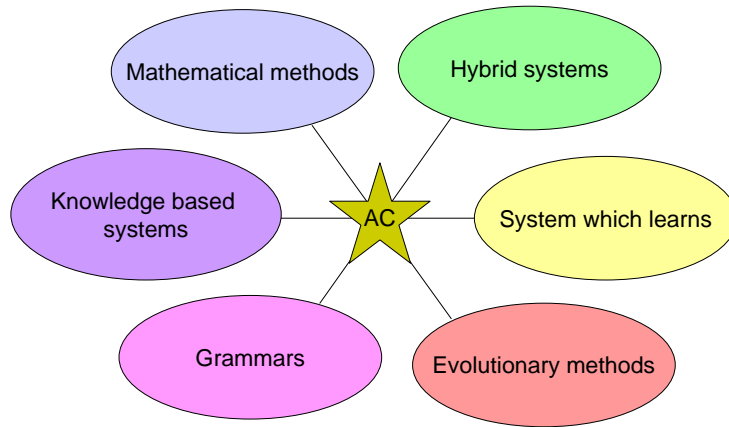
- Hiller and Isaacson (1959)
 - Hiller: composer, chemist at University of Illinois
 - Random number generator and Markov chains
 - The Illiac Suite for string quartet. (counterpoint + random white noise in experiment 2)



The survey



Representative Examples, Disadvantages...



Mathematical models



- Stochastic (Markov chains)
 - Cybernetic composer (Ames and Domino, 1992, Composer)
 - Four styles: "standard" jazz, Latin jazz, ragtime, and rock
 - Four working layers: solo, background chords, bass line, & drums
 - Pitch, rhythm, thematic structure, and other compositional choices are calculated by a series of rules.
- Chaos
 - Chaotic nonlinear system by Pressings (psychologist), 1988.
 - Iterated functions by Gogins, 1991
- Information Theory (entropy, unpredictability)
 - Conklin and Witten (dep. of computing), Bach chorale, generated

Disadvantages of Mathematical models

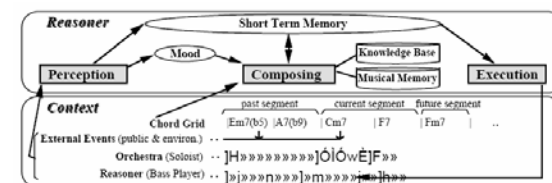


- Necessity of finding probabilities first.
- Difficulty of capturing higher or more abstract levels of music.
- Incapability of judging the results' quality.

Knowledge Based Systems (symbolic, rules + constraints)



- Rule-based expert system
 - Ebcioğlu, 1988, harmonization of chorales in Bach's style.
- Constraint logic programming
 - Pachet and Roy, 1998, harmonization. (melody harmonization)
- Case based reasoning
 - Ramalho and Genascia, simulating creativity in jazz.




Disadvantages of Knowledge Based Systems



- Knowledge elicitation is difficult and time consuming.
- Gaps between expert and programmer. (representation is not flexible)
- Too complicated with more exceptions to the rules.

Grammars



- Experiments in Musical Intelligence
 - Cope (composer), 1992
 - Extract “signatures” using pattern matching.
 - An EMI-composed Quartet for woodwind instruments in the style of Stravinsky. 
- Generative grammars for jazz chord progressions
 - Steedman (cognitive scientist), 1996
 - Chord progressions in 12-bar blues
- Also grammars for jazz
 - Johnson-Laird (psychologist), 1992
 - Chord progression generation and bass line improvisation




Disadvantages of Grammars



- The hierarchical structures in grammars are not flexible. (Ex. Improvisation is not hierarchical)
- Implementation do not make any strong claims about the semantics of the pieces.
- Many musical strings of questionable quality.
- Computationally expensive

Evolutionary methods - genetic algorithms



- An objective fitness function
 - McIntyre, four part Baroque harmonization of an input melody, 1994
 - Spector (cognitive scientist) & Alpern, four-measure melody output given a four-measure melody input, 1994
 - Bebop 
 - Papadopoulos & Wiggins, evolve jazz melody given a chord progression, 1998. 
- A human fitness function (interactive GA)
 - Jacob (engineer), composition system, 1995 
 - Ralley (computer scientist), input melody -> output melody, 1995
 - Biles (information scientist), GenJam, novice jazz musician learning to improvise, 1994. [\(video\)](#)



Disadvantages of Evolutionary methods



- Subjective
- Fitness bottleneck
 - the user must hear all the potential solutions in order to evaluate a population.
- No way to simulate human behavior.

System which learns



- Artificial Neural Network (ANN)
 - Melody: Todd (1989), Mozer (1994)
 - Harmonization: Bellgard & Tsang (1994)
 - Toiviainen (Prof. in music), Jazz improvisation (bebop), 1995. 
 - Hörnel, Baroque-style chorale variations, 1997.
melodic variation on “twinkle twinkle little star” 
 - Melo, capture harmonic tension by human experiment, 1998.
- Machine Learning (ML)
 - Not very common in implementation.
 - Cope, probabilistic grammar for harmonic movement in 17th century dance music, 1992.
 - Schwanauer, harmonization of chorale, 1993.

Disadvantages of ANN



- Fail to pick up the higher-level feature of music such as phrasing or tonal functions.
- Usually solve toy problems.
- Even can not reproduce fully the training set.
- Learning by examples, no filtering.

Hybrid Systems (combinations of AI)



- Gibson & Byrne, harmonization only using tonic subdominant and dominant chords with a combination of GA and ANN, 1991
- Biles, use ANN to improve GenJam, 1996.
- Burton & Vladimirova, use ANN to assign fitness function to GA for rhythm generation, 1997.
- Hild & Feulner, ANN with constraint satisfaction techniques for harmonization, 1992, 1993.

- Disadvantage: too complicated.

Online References



- Mozart's Dice Game, <http://sunsite.univie.ac.at/Mozart/dice>
- Lejaren Hiller, <http://pw1.netcom.com/~kallisti/Hiller.html>
- Cybernetic composer by Ames and Domino, <http://eamusic.dartmouth.edu/~wowem/hardware/algorithmdefinition.html>
- Chaotic nonlinear system by Pressings, <http://www2.psy.uq.edu.au/CogPsych/Noetica/OpenForumIssue8/Pressing.html>
- James Harley, <http://www.mnstate.edu/harley/harley.html>
- Iterated functions by Gogins, <http://ruccas.org/pub/Gogins/ChaoticSquares.mp3>
- Kemal Ebcioğlu, <http://www.global-supercomputing.com/people/kemal.ebcioğlu/>
- Geber Ramalho, <http://www.di.ufpe.br/~glr/>
- David Cope, <http://arts.ucsc.edu/faculty/cope/>
- Mark Steedman, <http://www.cogsci.ed.ac.uk/~steedman/>

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- Johnson-Laird, http://weblamp.princeton.edu/~psych/psychology/research/johnson_laird/publications.php
- McIntyre, http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=349943
- GenBebop, <http://helios.hampshire.edu/lspector/genbebop.html>
- Jacob, http://www.ee.umd.edu/~blj/algorithmic_composition/icmc.95.html
- Ralley, <http://www.dance.ohio-state.edu/~david/icmc/icmc.html>