7. Generative techniques

Generative Music AI

THE SOUND OF AI

upf. Universitat Pompeu Fabra Barcelona

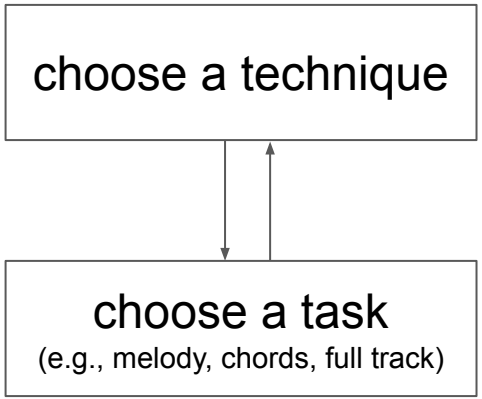
MTG Music Technology Group

Overview

1. Taxonomy of GM techniques
2. Overview of each category
3. One real-world example per category
4. Resources to learn more


I"LL DO EVERYTHING TO GENERATE SHUSIC"

History of GM in a nutshell



Generative music taxonomy

- Symbolic AI
- Optimization
- Complex systems
- Statistical methods
- Deep learning

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Traditional
(symbolic)

Cutting edge
(symbolic + audio)

Symbolic AI

- Reason on symbols

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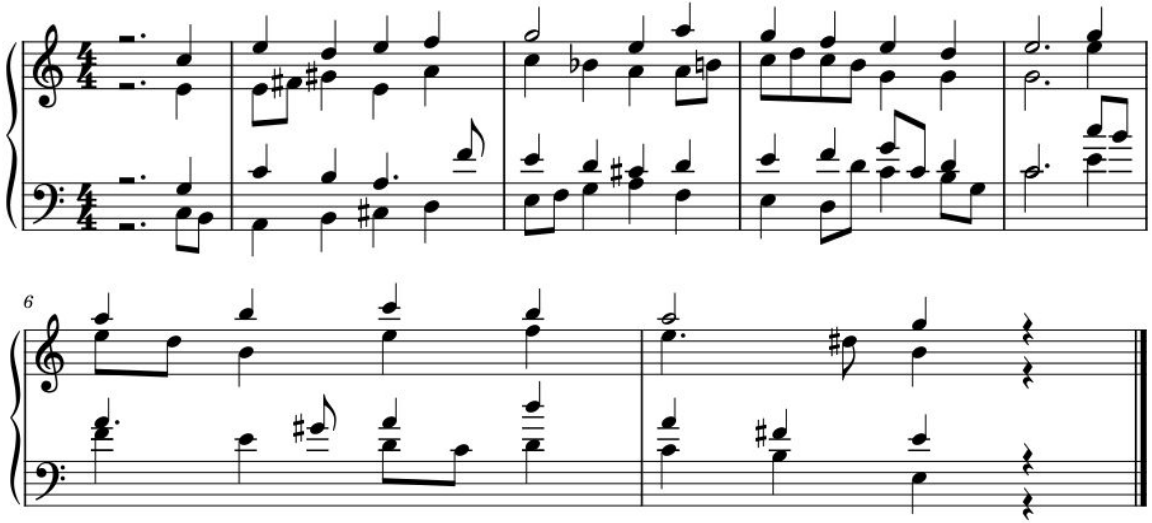
- Difficult to encode rules manually
- Example techniques
  - Generative grammars
  - Constraint satisfaction
  - Expert systems

CHORAL (Ebcioglu, 1990)

- Expert system
- Bach chorale generation
- 300+ rules
- Manually encoded
- Rules cover harmony, voice-leading, …

CHORAL (Ebcioglu, 1990)



Optimization

- Iteratively optimize fitness function

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- Imitate target style

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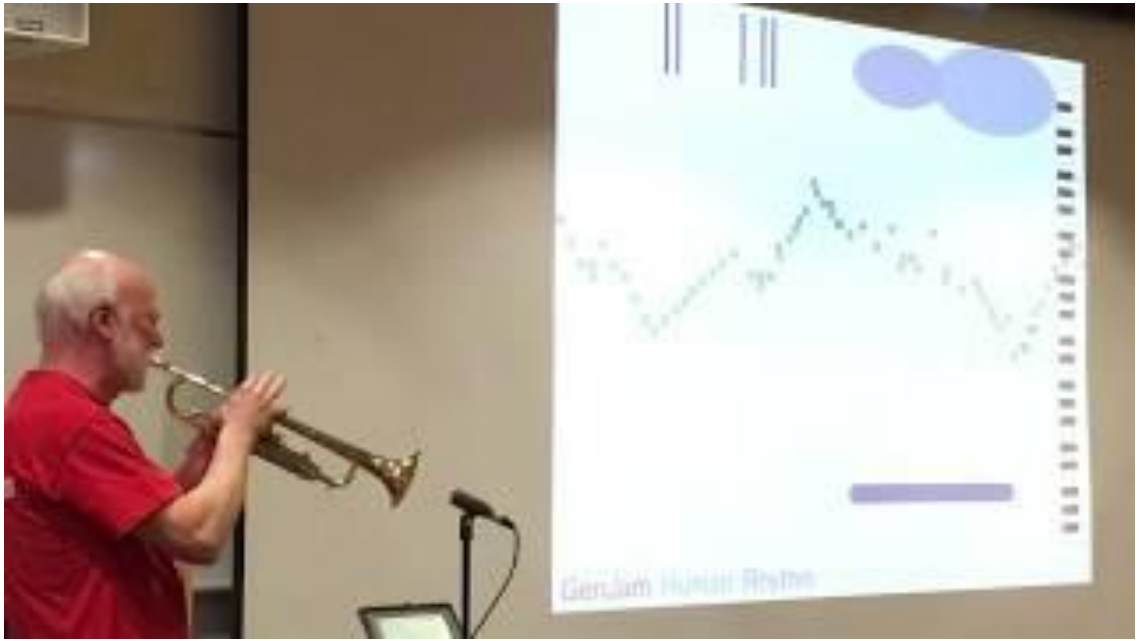
- Can be population based
- Example techniques
  - Genetic algorithms
  - Particle swarm optimization
  - Simulated annealing

GenJam (Biles, 1994)

- Real-time jazz solos
- Interactive genetic algorithm

GenJam (Biles, 1994)



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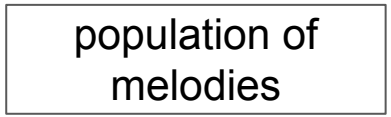

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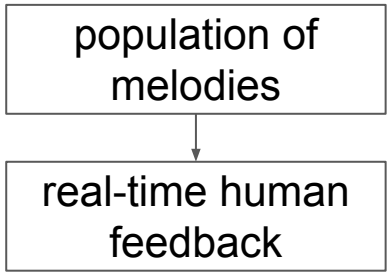

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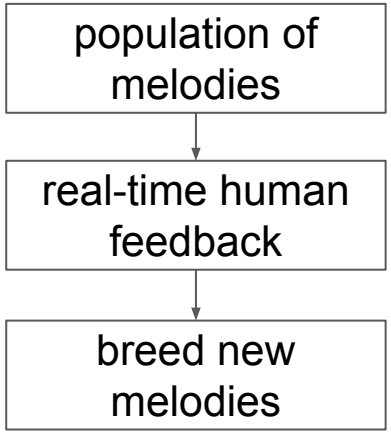

Complex systems

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  - Fractals
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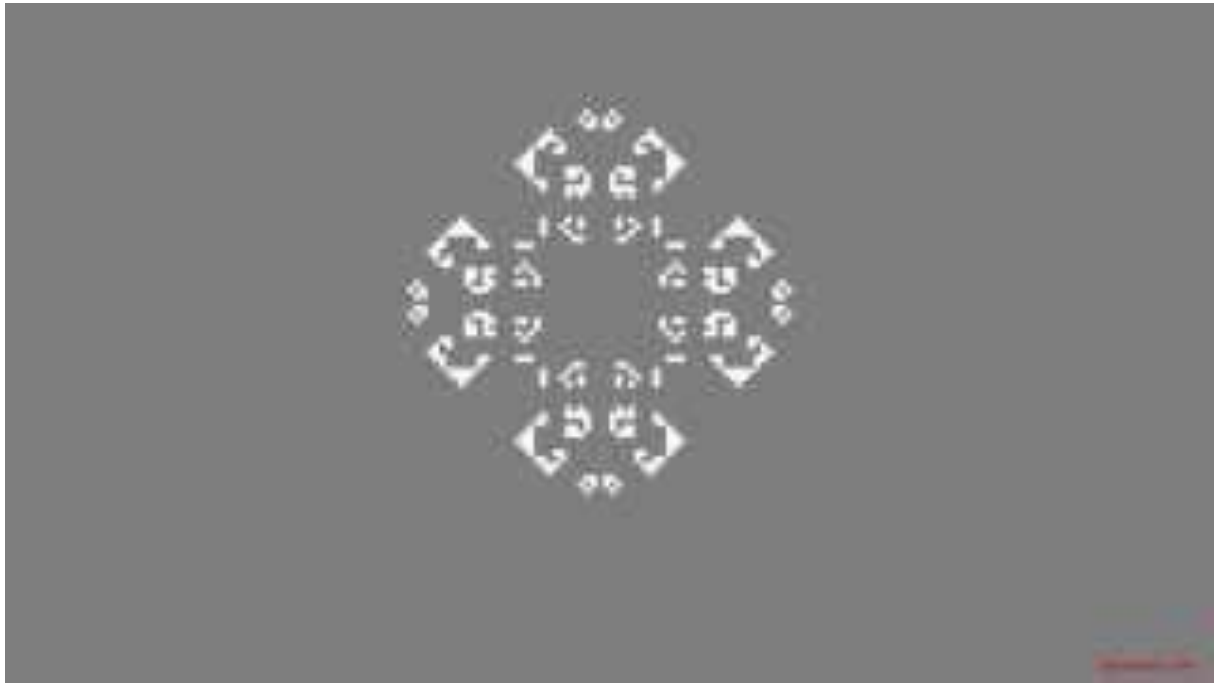
- Musical mapping is key

Conway’s Game of Life

- 2D grid
- Each cell is either alive or dead
- Cell is alive if 3 neighbours are alive
- Apply rule at every time step

Conway’s Game of Life



CAMUS (Miranda, 1993)

- 2D cellular automata
  - Determine pitch sequence (Conway’s Game of Life)
  - Determine instrument (Griffeath’s Crystalline Growths)

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- Each active cell mapped to 3 pitches
- Poor output -> music inspiration

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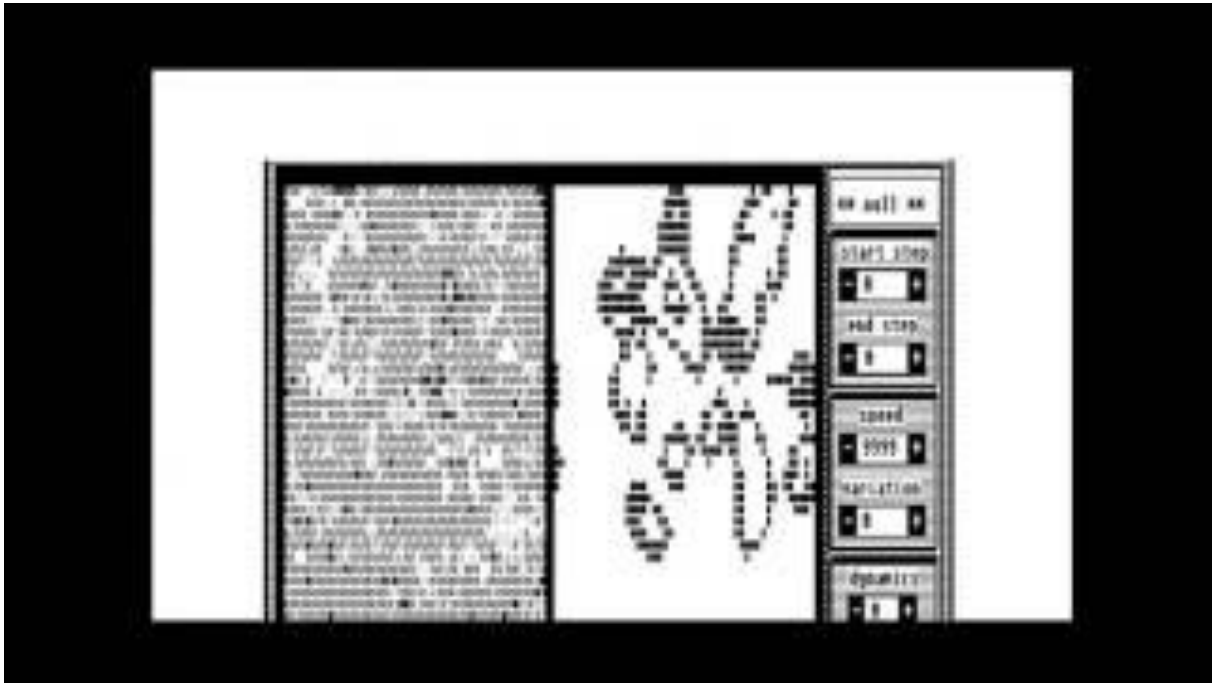

Statistical methods

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- Struggle with long-term dependencies
- Example techniques
  - Markov chains
  - Hidden markov models

Continuator (Pachet, 2002)

- Interactive music composition
- Piano improvisation
- Learn performer style
- Markov chains

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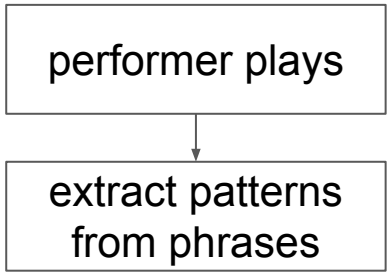

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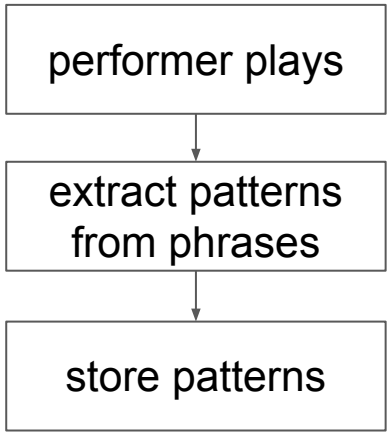

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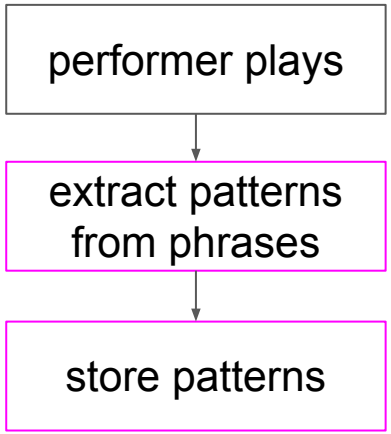

learning

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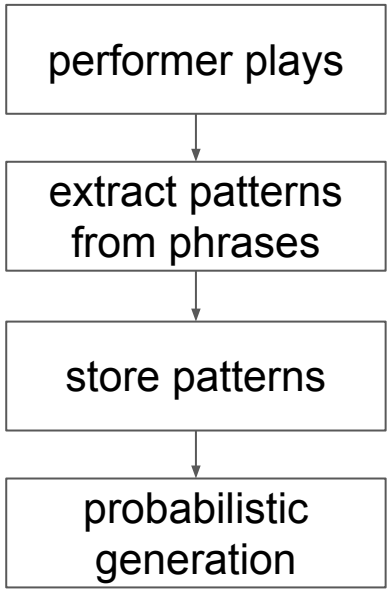


OMG... DL IS WILD
imgflip.com

Deep learning

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- Learn from massive datasets
- Imitate target style
- Audio / symbolic generation
- Computationally demanding
- Learn long-term dependencies
- No manual input

Deep learning: Architectures

- Recurrent neural nets (DeepBach, 2016)
- Variational auto encoders (Jukebox, 2020)
- Diffusion models (Riffusion, 2022)
- Transformers (MusicGen, 2023)

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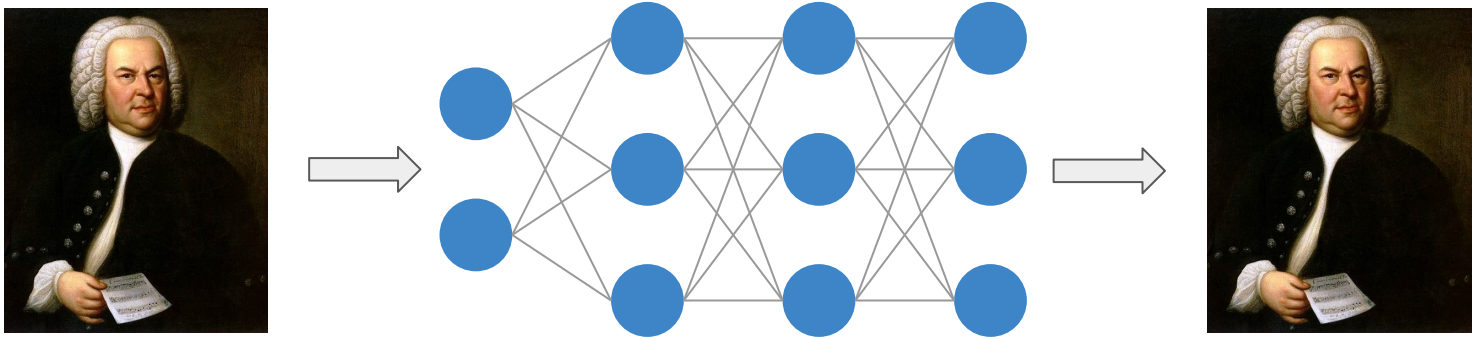
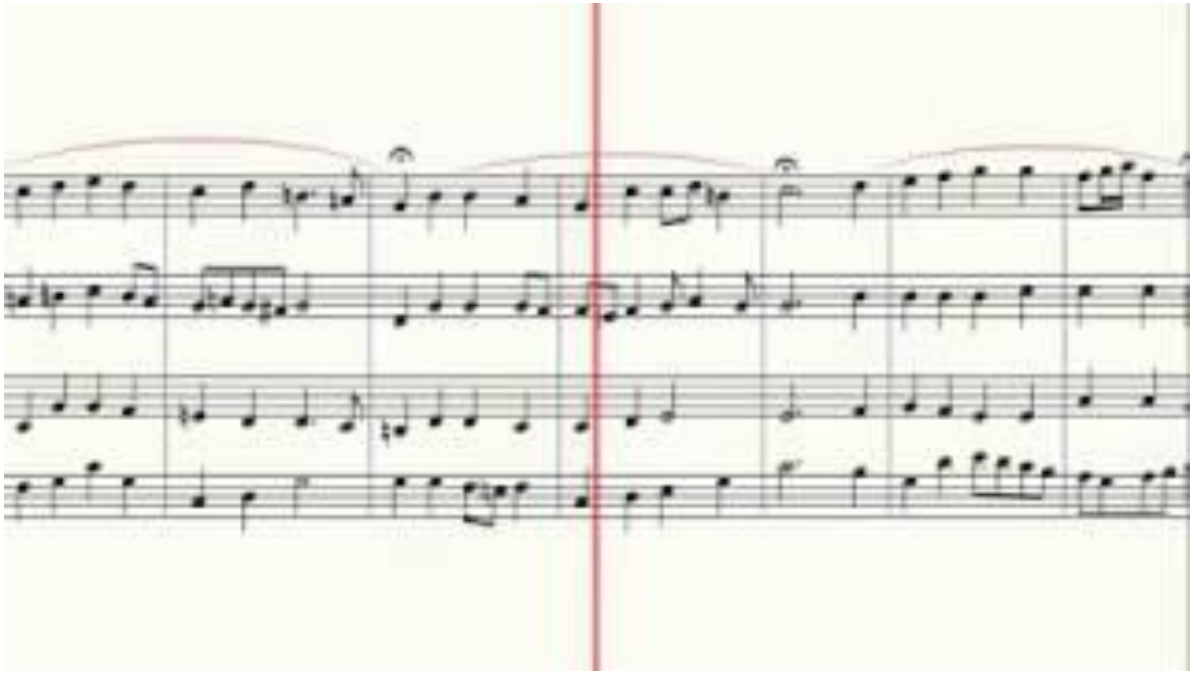
symbolic **audio**

DeepBach

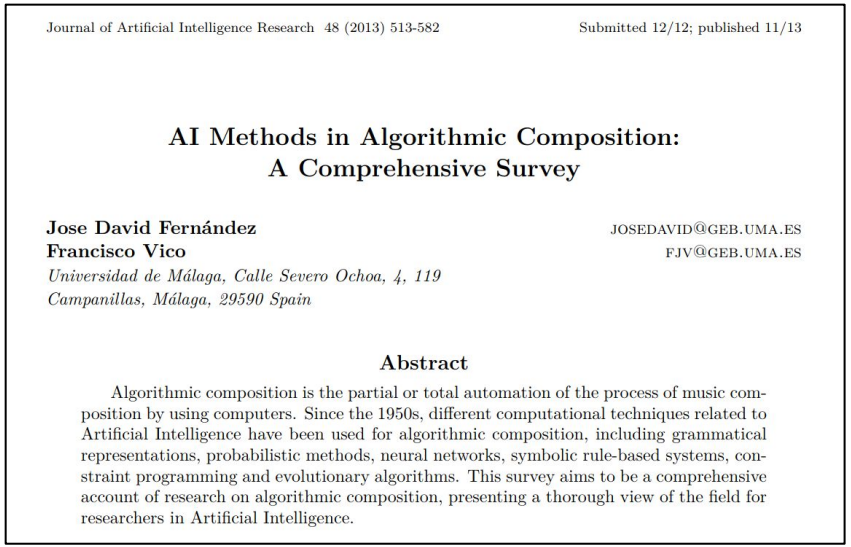


DeepBach



There is no silver bullet in Generative Music

To learn more



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AI Methods in Algorithmic Composition: A Comprehensive Survey

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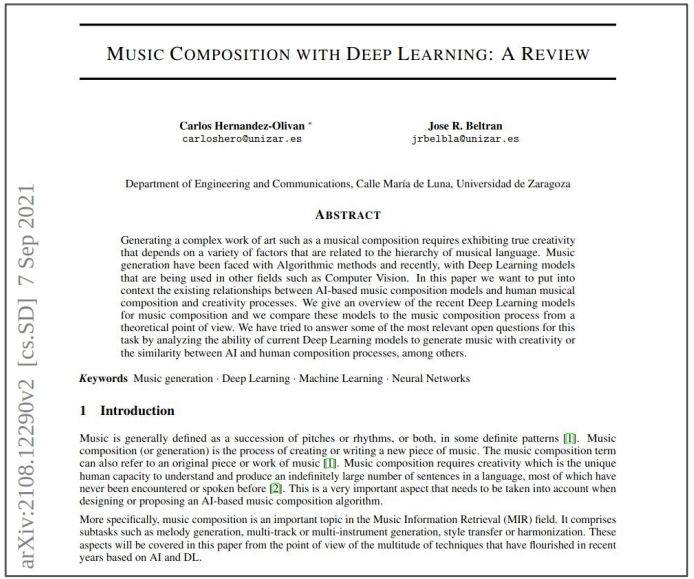
Abstract

Algorithmic composition is the partial or total automation of the process of music composition by using computers. Since the 1950s, different computational techniques related to Artificial Intelligence have been used for algorithmic composition, including grammatical representations, probabilistic methods, neural networks, symbolic rule-based systems, constraint programming and evolutionary algorithms. This survey aims to be a comprehensive account of research on algorithmic composition, presenting a thorough view of the field for researchers in Artificial Intelligence.



Music Composition with Deep Learning: A Review

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Abstract

Generating a complex work of art such as a musical composition requires exhibiting true creativity that depends on a variety of factors that are related to the hierarchy of musical language. Music generation have been faced with Algorithmic methods and recently, with Deep Learning models that are being used in other fields such as Computer Vision. In this paper we want to put into context the existing relationships between AI-based music composition models and human musical composition and creativity processes. We give an overview of the recent Deep Learning models for music composition and we compare these models to the music composition process from a theoretical point of view. We have tried to answer some of the most relevant open questions for this task by analyzing the ability of current Deep Learning models to generate music with creativity or the similarity between AI and human composition processes, among others.

Keywords Music generation · Deep Learning · Machine Learning · Neural Networks

1 Introduction

Music is generally defined as a succession of pitches or rhythms, or both, in some definite patterns [1]. Music composition (or generation) is the process of creating or writing a new piece of music. The music composition term can also refer to an original piece or work of music [1]. Music composition requires creativity which is the unique human capacity to understand and produce an indefinitely large number of sentences in a language, most of which have never been encountered or spoken before [2]. This is a very important aspect that needs to be taken into account when designing or proposing an AI-based music composition algorithm.

More specifically, music composition is an important topic in the Music Information Retrieval (MIR) field. It comprises subtasks such as melody generation, multi-track or multi-instrument generation, style transfer or harmonization. These aspects will be covered in this paper from the point of view of the multitude of techniques that have flourished in recent years based on AI and DL.

To learn more

Deep Learning for Music Generation

Key takeaways

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- GM techniques can be grouped in
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- GM techniques can be grouped in
  - Symbolic AI
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  - Deep learning
- Different techniques have different pros and cons

What next?

Limitations and vision for the future