

Chaos in the Garden. Human-assisted AI Composition in Experimental Spatial Music

By Henrik von Coler

AI and Spatialization

Applications of Artificial Intelligence (AI) have been manifold in the past decades. However, since the launch of the ChatGPT¹ chatbot in November 2022, the use of AI-based technologies has been growing exponentially in any field of human productivity and creativity. Our society is currently debating the future of such technologies, regarding the effects they might have on the structure of our working world and private lives.

There is consensus that these systems can and will perform repetitive and automatable tasks, even of high complexity. How and whether they can – or rather should – be used in creative processes is more controversial. This has already caused issues with copyright and intellectual property for AI-generated images (Hristov, 2016).

Large Language Models (LLMs) such as ChatGPT can be integrated into the conceptualization phase in any artistic discipline, by answering

prompts and thus influencing decisions in the design process. This article illustrates and discusses how this tool can be used to create a text-based score for experimental spatial music. Related work in AI-based composition and algorithmic methods for spatial audio practices will be presented in the introduction. Afterwards, the chat and the full score are presented. This is followed by an analysis and a report on a first performance based on the composition.

AI and ML in Music Creation

The use of tools and auxiliary agents in music composition is older than computers or mechanical devices. Dice were used to introduce chance into classical compositions (Hedges, 1978; Ruttkay, 1997). This can be considered an early example of technology-aided or algorithmic composition.

In computer music, algorithmic composition and computer-aided composition have been an integral part of its history (Supper, 2001). Early examples of computer-aided composition produced symbolic scores, based on algorithms and heuristics. These include Lejaren Hiller's work from 1955, Moorer's

rule-based systems and Xenakis' approach, who considered algorithmic composition a '*tool for constructing complex structures with minimum means*' (Roads, 1980). Lopez-Rincon et al. (2018) present a taxonomy of AI based music composition, dividing the field into *soft computing based music composition methods and symbolic AI based music composition methods*, both with additional subareas.

With increasing capabilities, artificial intelligence and machine learning (ML) can be incorporated into music composition and performance at many levels, including not only score generation, but also interactive performance and improvisation systems or complete sound and music synthesis methods.

Modern generative music systems, such as *WaveNet* (Oord et al., 2016) and OpenAI's *Jukebox* (Dhariwal et al., 2020) create complete musical pieces in the audio domain, in the style of artists included in the training data. *Noise2Music* (Huang et al., 2023) is a diffusion model, that generates audio from text prompts, similar to the well-known diffusion models for image generation.

Composition is not the only application scenario for AI and machine

learning in music. The integration of ML algorithms into human-computer interfaces for the control of digital musical instruments leads to a form of human-machine partnership (Fiebrink, 2017).

Algorithmic Spatialization

In the context of electroacoustic music, spatialization refers to the dynamic distribution of sound in composition or performance. Often this involves algorithms for controlling the spatial distribution, or more precisely the virtual positions of multiple sound sources in object-based spatialization (Schacher, 2018). Such algorithms can provide meta-parameters and semi-automated workflows, needed to control the many parameters involved in these processes.

Tools like *OM-Spat* (Garcia et al., 2015) and *OM-Prisma* (Schumacher and Bresson, 2010) allow algorithmic control over spatial audio processes in offline computer-aided composition. Applications also include spatial sound synthesis, based on algorithmically generated control trajectories.

Spatialization algorithms can also be derived from natural phenomena. For example, swarm behavior

has been used for various musical parameters in compositions (Kaliakatsos-Papakostas et al., 2020). The inherent spatial qualities of swarm motion predestine it for spatial aspects, as for example in swarm-based spatial granular synthesis (Wilson, 2008). A similar example uses Boids algorithm for spectral and granular spatialization (Kim-Boyle, 2006).

Other examples have more pragmatic applications. In a self-supervised framework for audio spatialization Lu et al., 2019, video data is used to generate 3D spatial audio from monophonic recordings. This procedure can be used to create immersive audio from simple recordings.

Spatial Performance Concepts

The performance of experimental music on spatial sound reproduction systems opens up a wealth of possibilities. Especially in the case of live electronics, the usual musical grid of time and pitch is not applicable. Complex synthesis systems, such as modular synthesizers or custom digital musical instruments (DMI) offer a wide range of parameters that cannot be expressed in musical notation. Additional spatial

parameters for each instrument require further structuring to allow for intentional control. Concepts for a guided improvisation are a means for adding this structure. Such concepts can be text-based instructions, graphical notations, or any type of conceptual guideline.

The Electronic Orchestra Charlottenburg (EOC)² is an ensemble that focuses on live electronic music for large loudspeaker systems. It has explored various approaches to guided improvisation, some of which include explicit treatment of the spatial aspect. These include their own compositions, adaptations of existing pieces and commissioned works.

Mark Applebaum's *S-Tog* (Applebaum, 1996), for example, is a graphical score, based on the train map of Copenhagen. Musicians travel fictitious routes on the map, realizing playing instructions that are connected to train stations on the map. For the EOC adaptation, automatic source movements were programmed, according to the musicians' routes on the map.

For Robert Stokow's *Coffee Rings* (Stokow and von Coler 2018; p. 34), the virtual source positions of each musician are controlled by signal

analysis. The detected pitches of the instruments determine the azimuth angle of a virtual sound source on a fixed radius. Thus, the source distribution is modulated according to the pitch distribution of all instruments.

Chaos in the Garden³

Concept

The goal of this experiment is to have the AI chatbot create a score for five arbitrary instruments, including instructions for the spatialization. Since the score is intended to be as open as possible, no tonal or instrument-specific instructions should be included. The system was instructed to remove or replace such content and asked to refine certain aspects, until a useful version was reached. Although the process is influenced by all prompts, the aesthetic concept was intentionally left to the chatbot as much as possible.

The Chat

The following text is the original conversation with the Large Language Model trained by OpenAI, based on the GPT-3.5 architecture. None of the steps were previously

planned but happened during the chat on April 14, 2023:

HvC

Create an experimental music score for 5 arbitrary instruments.

ChatGPT

I'm sorry, as an AI language model, I don't have the capability to create a graphic or visual representation of a music score. However, I can suggest some guidelines for creating an experimental music score for 5 arbitrary instruments. Here are some ideas:

Choose your instruments: Pick 5 arbitrary instruments that you want to use in your experimental music score. You can choose any instruments that you like, such as guitar, drums, violin, saxophone, trumpet, piano, or any other instruments.

Define the rules: Decide on the rules for your music score. For example, you can specify the tempo, key, time signature, or any other parameters that you want to include in your score. Alternatively, you can create a completely free-form score that has no rules or guidelines.

Create the score: Using a music notation software or pen and paper, create the score for each instrument. You can use traditional notation, graphic notation, or any other form of notation that you prefer. You can also use unconventional symbols or markings to convey specific instructions or ideas to the performers.

Rehearse and perform: Once you have created the score, rehearse with the performers and refine the score based on their feedback. Then, perform the piece in front of an audience and observe their reactions. Use their feedback to further refine your experimental music score.

Remember, experimental music is all about breaking rules and exploring new possibilities. So, don't be afraid to be creative and take risks. Good luck!

HvC

It can also be text-based.

ChatGPT

Thank you for letting me know. Here's a text-based experimental music score for 5 arbitrary instruments:

Title: "Chaos in the Garden"

Instruments:

Flute, Trumpet, Violin, Cello, Percussion

Instructions:

This score is a free-form experimental piece. The performers are encouraged to explore different sounds and techniques with their instruments. The score is divided into five sections, each representing a different aspect of a garden.

Section 1 - "The Calm Before the Storm"

Flute: Play long, sustained notes that gradually increase in volume. Trumpet: Play soft, airy notes that gradually become more urgent. Violin: Play slow, mournful melodies with occasional trills and glissandos. Cello: Play pizzicato notes that gradually become more rhythmic. Percussion: Use a variety of small percussion instruments to create a subtle, atmospheric background.

Section 2 - "The Storm Approaches"

Flute: Play short, staccato notes that increase in speed and intensity.

Trumpet: Play loud, dissonant notes with occasional growls and rumbles.

Violin: Play fast, frenetic melodies with frequent bow changes and spiccato.

Cello: Play aggressive, percussive notes using the bow and fingers.

Percussion: Use larger percussion instruments to create thunder-like sounds and crashes.

Section 3 - "The Storm Rages On"

Flute: Play trills and flutter-tonguing to create a chaotic, swirling effect.

Trumpet: Play aggressive, dissonant notes with frequent glissandos and growls.

Violin: Play fast, chaotic melodies with frequent use of extended techniques.

Cello: Play rapid arpeggios and sul ponticello to create a sense of urgency.

Percussion: Use a variety of percussion instruments to create a chaotic, unpredictable rhythm.

Section 4 - "The Aftermath"

Flute: Play soft, mournful melodies with occasional bird-like chirps.

Trumpet: Play soft, mournful notes with occasional growls and rumbles.

Violin: Play slow, mournful melodies with occasional use of harmonics and sul ponticello.

Cello: Play slow, mournful melodies with occasional use of glissandos and harmonics.

Percussion: Use small percussion instruments to create a subtle, atmospheric background.

Section 5 - "The Rebirth"

Flute: Play long, sustained notes that gradually become more hopeful.

Trumpet: Play soft, gentle notes with occasional bursts of joy.

Violin: Play slow, uplifting melodies with frequent use of vibrato.

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Cello: Play rapid arpeggios and tremolos to create a sense of urgency.

Percussion: Use a variety of percussion instruments to create a chaotic, unpredictable rhythm.

Section 4 - "The Aftermath"

Flute: Play soft, mournful melodies with occasional bird-like chirps.

Trumpet: Play soft, mournful notes with occasional growls and rumbles.

Violin: Play slow, mournful melodies with occasional use of harmonics and sul ponticello.

Cello: Play slow, mournful melodies with occasional use of glissandos and harmonics.

Percussion: Use small percussion instruments to create a subtle, atmospheric background.

Section 5 - "The Rebirth"

Flute: Play long, sustained notes that gradually become more hopeful.

Trumpet: Play soft, gentle notes with occasional bursts of joy.

Violin: Play slow, uplifting melodies with frequent use of vibrato.

Cello: Play slow, uplifting melodies with frequent use of harmonics and glissandos.

Percussion: Use a variety of percussion instruments to create a celebratory, upbeat rhythm.

Note:

The performers are encouraged to improvise and explore different sounds and techniques within each section. The score is meant to be a starting point for a free-form, experimental performance.

HvC

Thanks. Can you rewrite this without specifying the actual instruments?

ChatGPT

Sure, here's a text-based experimental music score that doesn't specify the actual instruments:

Title: "Chaos in the Garden"

Instruments: 5 arbitrary instruments

Instructions: This score is a free-form experimental piece. The performers are encouraged to explore different sounds and techniques with their instruments. The score is divided into five sections, each representing a different aspect of a garden.

Section 1 - "The Calm Before the Storm"

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Play long, sustained notes that gradually increase in volume. Play soft, airy notes that gradually become more urgent. Play slow, mournful melodies with occasional trills and glissandos. Play pizzicato notes that gradually become more rhythmic. Use a variety of small percussion instruments to create a subtle, atmospheric background.

Section 2 - "The Storm Approaches"

Play short, staccato notes that increase in speed and intensity. Play loud, dissonant notes with occasional growls and rumbles. Play fast, frenetic melodies with frequent bow changes and spiccato. Play aggressive, percussive notes using the bow and fingers. Use larger percussion instruments to create thunder-like sounds and crashes.

Section 3 - "The Storm Rages On"

Play trills and flutter-tonguing to create a chaotic, swirling effect. Play aggressive, dissonant notes with frequent glissandos and growls. Play fast, chaotic melodies with frequent use of extended techniques. Play rapid arpeggios and tremolos to create a sense of urgency. Use a variety of percussion instruments to create a chaotic, unpredictable rhythm.

Section 4 - "The Aftermath"

Play soft, mournful melodies with occasional bird-like chirps. Play soft, mournful notes with occasional growls and rumbles. Play slow, mournful melodies with occasional use of harmonics and sul ponticello. Play slow, mournful melodies with occasional use of glissandos and harmonics. Use small percussion instruments to create a subtle, atmospheric background.

Section 5 - "The Rebirth"

Play long, sustained notes that gradually become more hopeful. Play soft, gentle notes with occasional bursts of joy. Play slow, uplifting melodies with frequent use of vibrato. Play slow, uplifting melodies with frequent use of harmonics and glissandos. Use a variety of percussion instruments to create a celebratory, upbeat rhythm.

Note:

The performers are encouraged to improvise and explore different sounds and techniques within each section. The score is meant to be a starting point for a free-form, experimental performance.

HvC

Thanks again. Can you also remove the concept of melodies and tonality in general?

ChatGPT

Sure, here's a revised version of the experimental music score without the concept of melodies and tonality:

Title: "Chaos in the Garden"

Instruments: 5 arbitrary instruments

Instructions: This score is a free-form experimental piece. The performers are encouraged to explore different sounds and techniques with their instruments. The score is divided into five sections, each representing a different aspect of a garden.

Section 1 - "The Calm Before the Storm"

Play long, sustained sounds that gradually increase in volume. Play soft, airy sounds that gradually become more urgent. Play pizzicato or plucked notes that gradually become more rhythmic. Use a variety of small percussion instruments to create a subtle, atmospheric background.

Section 2 - "The Storm Approaches"

Play short, staccato sounds that increase in speed and intensity. Play loud, dissonant sounds with occasional growls and rumbles. Use the bow or fingers to create aggressive, percussive sounds. Use larger percussion instruments to create thunder-like sounds and crashes.

Section 3 - "The Storm Rages On"

Use extended techniques such as trills, flutter-tonguing, and growls to create a chaotic, swirling effect. Play aggressive, dissonant sounds with frequent use of glissandos. Use a variety of percussion instruments to create a chaotic, unpredictable rhythm.

Section 4 - "The Aftermath"

Play soft, mournful sounds with occasional bird-like chirps. Play slow, mournful sounds with occasional growls and rumbles. Use small percussion instruments to create a subtle, atmospheric background.

Section 5 - "The Rebirth"

Play long, sustained sounds that gradually become more hopeful. Play soft, gentle sounds with occasional bursts of joy. Use a variety of percussion instruments to create a celebratory, upbeat rhythm.

Note: The performers are encouraged to improvise and explore different sounds and techniques within each section. The score is meant to be a starting point for a free-form, experimental performance without the constraints of tonality or traditional melodies.

HvC

Thanks, that is much better. There are still some references to instruments in the score, such as flutter-tonguing. Can you also rephrase these?

ICMA awards

By **Per Magnus Lindborg and Christopher Haworth** "Chaos in the Garden"

Instruments: 5 arbitrary instruments

Instructions: This score is a free-form experimental piece. The performers are encouraged to explore different sounds and techniques with their instruments. The score is divided into five sections, each representing a different aspect of a garden.

Section 1 - "The Calm Before the Storm"

Play sustained sounds that gradually increase in volume. Play soft, airy sounds that gradually become more urgent. Use plucking or striking techniques to create a rhythmic background. Use small percussion instruments to create a subtle, atmospheric texture.

Section 2 - "The Storm Approaches"

Play short, percussive sounds that increase in speed and intensity. Play dissonant sounds with occasional harsh, metallic textures. Use striking techniques to create aggressive, percussive sounds. Use larger percussion instruments to create thunderous sounds.

Section 3 - "The Storm Rages On"

Use a variety of extended techniques to create a chaotic, swirling effect. Play dissonant sounds with frequent use of glissandos and pitch bending. Use percussion instruments to create unpredictable, irregular rhythms.

Section 4 - "The Aftermath"

Play soft, mournful sounds with occasional bird-like chirps or rustling sounds. Use small percussion instruments to create a subtle, atmospheric texture.

Section 5 - "The Rebirth"

Play sustained sounds that gradually become more uplifting. Play soft, gentle sounds with occasional bursts of energy. Use percussion instruments to create a celebratory, rhythmic texture.

Note: The performers are encouraged to improvise and explore different sounds and techniques within each section. The score is meant to be a starting point for a free-form, experimental performance without the use of any instrument-specific terms or traditional melodies.

HvC

What length should this piece have?

ChatGPT

The length of the experimental music piece can vary depending on the interpretation and improvisation of the performers. The score is intended to be a flexible and open-ended framework, allowing the performers to explore and experiment with different sounds and techniques for each section. The duration of the piece can range from a few minutes to an hour or longer, depending on the performers' choices and the desired effect.

HvC

Can the spatialization be part of the score?

ChatGPT

Yes, the spatialization can definitely be part of the experimental music score. Spatialization refers to the distribution of sound in physical space, and can add another layer of creativity and experimentation to the piece. Here's a revised version of the experimental music score that includes spatialization instructions:

Title: "Chaos in the Garden"

Instruments: 5 arbitrary instruments

Instructions: This score is a free-form experimen-

Title: "Chaos in the Garden"

Instruments: 5 arbitrary instruments

Instructions: This score is a free-form experimental piece. The performers are encouraged to explore different sounds, techniques, and spatialization with their instruments. The score is divided into five sections, each representing a different aspect of a garden.

Section 1 - "The Calm Before the Storm"

Play sustained sounds that gradually increase in volume, panning from left to right. Play soft, airy sounds that gradually become more urgent, panning from front to back. Use plucking or striking techniques to create a rhythmic background, with different sounds appearing in different parts of the space. Use small percussion instruments to create a subtle, atmospheric texture, with sounds placed throughout the space.

Section 2 - "The Storm Approaches"

Play short, percussive sounds that increase in speed and intensity, with different sounds appearing in different parts of the space. Play dissonant sounds with occasional harsh, metallic textures, with different sounds appearing in different parts

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of the space. Use striking techniques to create aggressive, percussive sounds, with sounds placed throughout the space. Use larger percussion instruments to create thunderous sounds, panning from front to back.

Section 3 - "The Storm Rages On"

Use a variety of extended techniques to create a chaotic, swirling effect, with sounds swirling around the space. Play dissonant sounds with frequent use of glissandos and pitch bending, with sounds moving throughout the space. Use percussion instruments to create unpredictable, irregular rhythms, with sounds placed throughout the space.

Section 4 - "The Aftermath"

Play soft, mournful sounds with occasional bird-like chirps or rustling sounds, with sounds placed throughout the space. Use small percussion instruments to create a subtle, atmospheric texture, with sounds placed throughout the space.

Section 5 - "The Rebirth"

Play sustained sounds that gradually become more uplifting, panning from right to left. Play soft, gentle sounds with occasional bursts of energy, with sounds placed throughout the space. Use percussion instruments to create a celebratory, rhythmic texture, with sounds placed throughout the space.

Note: The performers are encouraged to improvise and explore different sounds, techniques, and spatialization within each section. The score is meant to be a starting point for a free-form, experimental performance that incorporates spatialization as a creative element.

HvC

Can you refine "sounds placed throughout the space" for the different sections?

ChatGPT

Sure, here's a refined version of the spatialization instructions for each section:

Section 1 - "The Calm Before the Storm"

Play sustained sounds that gradually increase in volume, panning from left to right and front to back. Play soft, airy sounds that gradually become more urgent, panning from front to back and moving around the space in a random pattern. Use plucking or striking techniques to create a rhythmic background, with sounds placed

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in different areas of the space and moving around in a circular pattern. Use small percussion instruments to create a subtle, atmospheric texture, with sounds placed in different areas of the space and moving around in a random pattern.

Section 2 - "The Storm Approaches"

Play short, percussive sounds that increase in speed and intensity, with sounds placed in different areas of the space and moving around in a random, chaotic pattern. Play dissonant sounds with occasional harsh, metallic textures, with sounds placed in different areas of the space and moving around in a circular pattern. Use striking techniques to create aggressive, percussive sounds, with sounds placed in different areas of the space and moving around in a random pattern. Use larger percussion instruments to create thunderous sounds, panning from front to back and moving around the space in a circular pattern.

Section 3 - "The Storm Rages On"

Use a variety of extended techniques to create a chaotic, swirling effect, with sounds swirling around the space in different directions. Play dissonant sounds with frequent use of glissandos and pitch bending, with sounds placed in different areas of the space and moving around in a random, unpredictable pattern. Use percussion instruments to create unpredictable, irregular rhythms, with sounds placed in different areas of the space and moving around in a circular or random pattern.

Section 4 - "The Aftermath"

Play soft, mournful sounds with occasional bird-like chirps or rustling sounds, with sounds placed in different areas of the space and moving around in a random, gentle pattern. Use small percussion instruments to create a subtle, atmospheric texture, with sounds placed in different areas of the space and moving around in a circular or random pattern.

Section 5 - "The Rebirth"

Play sustained sounds that gradually become more uplifting, panning from right to left and moving around the space in a random, celebratory pattern. Play soft, gentle sounds with occasional bursts of energy, with sounds placed in different areas of the space and moving around in a circular or random pattern. Use percussion instruments to create a celebratory, rhythmic texture, with sounds placed in different areas of the space and moving around in a random, energetic pattern.

HvC

The piece should be about 15 minutes long. Can you add a timeline for the sections?

- around in a circular or random pattern (3 occurrences)
10. sounds placed in different areas of the space and moving around in a random, gentle pattern
 11. panning from right to left and moving around the space in a random, celebratory pattern
 12. sounds placed in different areas of the space and moving around in a random, energetic pattern

The instructions listed above correspond to typical methods used in spatial music practice. Circular, random and chaotic patterns are often used for source movements, including performances by the EOC.

Although attributes such as *swirling*, *unpredictable*, *gentle*, *energetic* and *celebratory* are rather vague, they are interpretable and conclusive. Some instructions even include specific directions, like *from left to right and front to back*.

In most cases, the spatial instructions are coherent with the overall character of the sections and the instructions for the instrumental performers. Hectic movements such as *swirling*, *unpredictable* and *chaotic* appear in the more dramatic Sec-

tions 2 and 3, combined with dissonant sounds, aggressive sounds and irregular rhythms. The releasing tension of Section 4 is supported by gentle patterns, while the uplifting character of Section 5 is emphasized by celebratory and energetic movements.

Rehearsal and Performance

The composition was premiered on May 22 2023 by the Electronic Orchestra Charlottenburg (EOC)² as part of the *Intersonanzen* festival⁵ in Potsdam, Germany. During rehearsal and performance, the ensemble's main goal was to do justice to the AI's 'compositional intentions', in order to bring out the arc of tension and the individual character of the five sections.

Since some aspects of the score are left open to a certain extent, the ensemble made the according decisions. Each phrase in the sections' instructions was assigned to one or more of the four musicians on stage. The sound director used a combination of Python⁶, Supercollider⁷ and hardware input devices to implement the spatial instructions during the performance.

Discussion

Chaos in the Garden is the result of using an AI-chatbot as a tool for creating an experimental score. Regardless of the instruments used in a performance, any interpretation of the piece can be considered 'computer music,' since it would not have been possible without the help of a specific software.

The cornerstones of the concept were specified by the user, whereas the overarching structure and the topos have been chosen by the system. Being trained on existing texts and data found in the internet, the question arises whether the composition is original or a combination of related material and publications. Even this simple example raises the question of authorship and copyright. A subsequent Google search found several pieces of music with the same title from different musical genres, none of them related to experimental spatial music.

Bown (2021) presents a model for human-computer interaction in creative processes. It starts with a human intention and then enters an iterative cycle of machine output and user evaluation, until the desired result is achieved. The creation

of *Chaos in the Garden* follows a similar pattern. However, ideally the machine does not assist the composer but the composer assists the machine in reaching a form that can be used as a score. In this case, the abort criterion is in the hands of the user, who decides whether to continue altering the score through additional prompts. With further prompts, the instructions might become even more specific. This, however, would further bias the system and it would lose its claim on authorship with every step.

The creative process involves *direct guidance, assistance or input of human beings* (Hristov, 2016) and can not be considered an autonomously generated AI creation. Considering the concept of CREATIVITY by Moruzzi (2018), the system did not act autonomously in the reception, selection or elaboration of stimuli. Hence, it did not create a musical work, but was merely used as a tool in a creative process. According to ChatGPT 4.0, however, the *'interaction in creating this piece can be considered a collaboration'*. Ultimately, *Chaos in the Garden* is considered a human-assisted AI composition.

Notes

- [1] <https://chat.openai.com>
- [2] <https://eo-charlottenburg.de>
- [3] Project website with recordings and further information https://eo-charlottenburg.de/repertoire/chaos_in_the_garden/
- [4] <https://www.pygame.org>
- [5] <https://www.potsdam-museum.de/veranstaltung/intersonanzen-2023>
- [6] <https://www.python.org/>
- [7] <https://supercollider.github.io/>

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