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Computer Creativity In Mid-Twentieth Century Music Composition

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Abstract   Creativity is widely acknowledged as a fundamental ability of human intelligence. During the emergence of artificial intelligence (AI) in mid-twentieth century, the computer's potential for creativity was one of the central topics to the debate whether machines can think. This research is based on the argument that traditional algorithmic implementations of music composition contributed to the understanding of human creativity as a process. The study focuses on music generation approaches within the realm of early AI. The nascence of computer-generated music coincides with the emergence of mainframe computers. Information theory concepts influenced the experiments in field. Mathematical methods of stochastic and randomization were utilized in the algorithms. Pioneering research sought to elucidate the procedural mechanisms utilized by individuals during the creative process, rather than to produce outcomes of significant aesthetic or artistic value. This work was conducted following qualitative historical research. The research is based on textual analysis of published archival and contemporary literature and serves a qualitative and interpretive approach. Although the primary focus of this investigation remains on traditional applications, the study concludes with an analysis of current state-of-the-art developments to establish a seamless historical narrative.

Computer Creativity In Mid-Twentieth Century Music Composition
Introduction

The level of sophistication of human mental processes has traditionally served as the primary benchmark for machine intelligence, and eventually for what artificial intelligence (hereafter AI) endeavors to achieve. Creativity is cited as a key feature that distinguishes human intelligence from its of machine counterpart (Arf, 1959).

Creative ability can be defined as capacity to generate ideas or artefacts that are novel, unpredictable, and inherently valuable. In this regard, "ideas" encompasses a wide range of intangible results including scientific theories, musical compositions, and culinary receipts, while "artefacts" refers to physical outcomes ranging from paintings to sophisticated mechanical engineering (Boden, 2004).

The influential cognitive scientist Margaret Boden introduced three different forms of creativity in her conceptual studies, that are attributed to combination, exploration, and transformation of ideas or artefacts (Boden, 1998; Boden, 2009). Accordingly, combinational type of creativity is achieved by associating known ideas or artefacts, thereby generating unfamiliar combinations of the familiar items. A collage designed in the form of virtual arts serves as a primary illustration of this classification. Exploratory creative act, on the other hand, is a function of searching a conceptual space defined by culturally implicit generative rules. In this context, novelty is governed by the generative rules, as in the case of generating grammatically correct sentences. Transformational creativity diverges from exploratory methods by actively modifying the conceptual space by the alteration of its original governing rules. The distinction between exploratory and transformational remains challenging as the boundary between a rule's transformative alteration and minor refinement remains conceptually vague.

A creative product or an act is expected to be original and valuable. While the concept of implementing creativity through the computer's deterministic, algorithm-bound platform presents an inherent contradiction to the requirements for originality and flexibility, a notable amount of research continue in the field, triggered by a variety of motivations (Carnovalini and Rodà, 2020; Rohrmeier, 2022).

The influential cognitive scientist Margaret Boden (2009) argued that most computer models for creativity are designed by the scientist with the intention to illuminate how the creative process works in the human mind, whereas the artistic practitioners focus on the artistic performance of their programs in generating creative outcomes of artistic value. The artistic performance may be achieved by the interaction of a computer and human being or by the computer stand-alone as part of generative art where the AI system itself is credited with creativity. Evolutionary art is such a case where the computer becomes the producer of the novel outcomes beyond the imagination of its human programmer.

The question of whether a computer can be ever creative is philosophical rather than scientific and remains unanswerable (Boden, 2009). Although scientific explanation for the creativity of the human being remains elusive, this article is based on the hypothesis that the computer-based experiments in the creative field have been facilitating understanding the human creativity as a phenomenon. The research paper investigates the historical pathway followed by artificial intelligence implementation approaches in the field of creative artwork, focusing on music composition. The question of how computer-based music composition experiments historically contributed to the understanding of creativity is explored.

The practice of history writing requires admitting that the past cannot be completely reconstructed as it was. Nevertheless, historical narration is an effective approach for framing facts within a story in a more

comprehensible structure to the reader (Dahlhaus, 1983). Starting with the traditional algorithmic compositions during the middle of the twentieth century, the evolving definition of creativity within the context of music is explored as part of this study. The progression from early rule-based compositional frameworks to contemporary advancements in artificial intelligence methodologies is projected. The ultimate aim of the research is to illustrate the contribution of computer-aided musical composition to the evolving definition of creativity.

The literature review revealed the existence of diverse and dispersed sources pertaining to the topics of AI history, creativity, and music composition. However, this research's principal contribution involves offering a thorough historical account synthesized within the framework of a critical review. The work aims to identify the motivation underpinning early experiments in the field of creative music. The study contributes to the existing historiography by analyzing primary resources on the computer music history and critical text, eventually compiling them with new insights into a comprehensive report. Additionally, the report incorporates a survey of recent scholarly works to bring the investigation up to the present day.

Method

The study was conducted following historical research methodologies from the fields of science and technology and intellectual history. The research was initiated by examining literature through academic journals, portals and thesis centers related to the topic. It was based on the textual analysis of published archival and contemporary literature and serves a qualitative and interpretive approach.

The scope of the research was identified primarily as the mid-20th century music composition when artificial intelligence was emerging as a distinct field. Prior and subsequent developments were briefly conveyed to ensure an integrated and holistic historical narrative.

Initial implementation attempts in the field of computer-based music composition were analyzed by investigating traditional algorithmic approaches. In concluding the investigation, a synthesis was performed to identify common aspects in formulizing the creative processes. The research article presents a comprehensive compilation of the study's findings with a critical review of the existing literature.

Findings

Tracing the definition of computational creativity;

The question of whether machine intelligence can demonstrate creativity has inspired the field of arts and scientific experiments throughout the history. The nascence of computer-generated arts coincides with the emergence of mainframe computers in the 1950s. Cybernetics and information aesthetics concepts influenced early art production experiments by the computer during 1960-70s (Dreher, 2020). Contemporary computer-generated art rely heavily on the application of machine learning algorithms. The application of artificial intelligence frameworks extends across various creative domains, including music composition, literature, and visual arts (Ballı, 2020).

Within the developmental history of machine intelligence in the nineteenth-century, Lady Ada Lovelace is recognized as a collaborator on Charles Babbage's early work of nascent computing. She famously argued against the notion of machine creativity in terms of originating anything, noting that the engine could only realize the processes that its designers "know how to order it to perform" (Boden: 2004, p.16). Alan Turing, in his ground-breaking article on machine intelligence dating back to mid-twentieth century, rephrased Lovelace's argument into the notion of "a machine can never 'take us by surprise'" (Turing: 1950, p. 450), and contested to that the surprising of an observer would require an underlying creative mental act. Turing rejected the solipsist argument which claims that the only way to know thinking is through subjective

identity, and suggested a test for intelligence that can be applied based on the perceived quality of the output produced, rather than by questioning the internal consciousness of the machine.

In the twentieth century, research in machine creativity progressed as an interdisciplinary field. Margaret Boden (2004) proposed a distinction between psychological novelty (P-creativity) and historical novelty (H-creativity). According to this framework, P-creativity identifies ideas that are fundamentally new to an individual, whereas H-creativity refers to those that are novel within the entirety of recorded human history. While the creative process is often associated with chance, chaos, randomness and unpredictability, Boden's framework for computational creativity suggested that novelty emerges from a structured navigation of a conceptual space. According to this proposal, constraints are not opposite to randomness; rather, they provide the necessary platform that allows individual observers to recognize and validate novel ideas and artefacts. Creativity is computationally realized through generative systems—which define the structural search space that encompasses computational possibilities—and heuristics, which provide the strategic "trial and error" logic required to selectively and insightfully navigate and transform that space. Data and action-rules together form the generative system with potentially infinite set of solutions within a search space that is pruned and used for problem solving by means of heuristics. By applying domain-specific knowledge, such as the harmonic rules of Western music, artificial intelligence ecosystem provides a dynamic environment to generate outcomes that are surprising and at the same time not bewildering to the audience, eventually generating novel and valuable outcomes within an established domain.

Existing literature confirms to that contemporary research in computational creativity pursues comprehending how creativity works and exploring to what extend it can be replicated by the computer. Practitioners of social scientists in the field tend to examine the creative process itself whereas artists are looking for a way to collaborate with AI to amplify their own creativity (Boden, 2009; Carnovalini and Rodà, 2020).

Computer-based music generation: Historical analysis with focus on mid-twentieth century

Automated music making dates to much earlier than the emergence of universal computer in the twentieth century. Historical records indicate a wind instrument designed by Appolonius of Perga, 247-205 BC, as one of the earliest automatic musical instruments. The thirteenth century witnessed Dutch musical engineers design of binary programmable carillons with up to ten thousand memory locations. The music playing automata fascinated the eighteenth-century society, especially with the machines introduced by Jacquet-Droz in Europe. Music boxes that were constructed by punched metal-disk technology mostly emerged during the nineteenth century and evolved into an automated orchestra; the orchestrion. The nineteenth century further introduced the electric phonograph and the microphone, enabling the storage of the sound as a novelty. The twentieth century marked the transition from the mechanical age to the electronic age. In music production, electromechanical techniques enabled storing and reproducing recorded music (Roads, 1980).

Music is known as a field where the available technology in a certain era has always been utilized at most. Computer music started as soon as the universal machines entered the scene although automatic computers were initially constructed with the fundamental purpose of coping with the challenges in complex mathematical calculations required of humans, and the music making using the computer was not an ordinary idea. Early machines were producing raw sound. Some of them possessed a loudspeaker unit that was used by the programmer or the maintenance engineer to communicate with the computer; for example, certain sound output indicated termination of the program during the execution, or a signal was used as diagnostic aid for the users (Doornbusch, 2017).

Computer music represents music played or composed by the machine. The performance of a music piece by the computer is conducted through converting scores into electronic sound. Music composition, on the other hand, requires the selection of notes (Hiller, 1981). The middle of the twentieth century hosted various experiments in the algorithmic music composition. One of the initial algorithmic music compositions produced by the extensive use of a digital computer was the Illiac Suite for String Quartet. The composer Lejaren Hiller, together with the mathematician Leonard Isaacson, completed the quartet in November 1956 that was eventually published with eighteen minutes duration. The composition was generated using the Illinois Automatic Computer I (hereafter ILLIAC) at the University of Illinois at Urbana-Champaign. Shortly before the performance of an incomplete version of the Illiac Suite in August 1956, another music piece by Douglas Bolitho and Martin L. Kleinm, the Push Button Bertha, became public on the television program Adventure Tomorrow (Ariza, 2011; Hiller, 1981).

Two of the pioneering projects in the history of computer aided algorithmic composition are reported by Ariza (2011). In 1955, the work of David Caplin and Dietrich Prinz introduced new musical structures. Apart from that, the work of Harriett Padberg in the early 1960s became one of the earliest academic works in the history of computer aided algorithmic composition, in particular published by a female figure. Both experiments were based on applying novel techniques on existing music.

Caplin and Prinz implemented formerly defined procedural approaches based on the dice games attributed to Mozart while experimenting with conditional probabilities to generate melodic lines. The implementation of Mozart's *Musikalisches Würfelspiel* by the computer employed both basic synthesis technique and a random number generator. The Ferranti Mark I computer was used in their initial experiments, and later, the more powerful machine Ferranti Mercury. In 1960, Caplin shared their computer based music experiments in a letter with Lejaren Hiller (Ariza, 2011).

Harriet Padberg referred to Guido of Arezzo's pitch-to-vowel mapping technique while designing a composition system. Her PhD dissertation from 1964, Computer-Composed Canon and Free Fugue, proposed a system for the algorithmic generation of canons and free fugues. The publication covered implementation details, the entire FORTRAN language code and score tables of complete compositions. Padberg, as quoted in Ariza (2011, p. 48), did not aim to produce a masterpiece using computer: "...it is evident that no exclusive use of mechanical devices, no matter how logical these may be, is sufficient to produce a masterpiece in any medium". She was rather concerned with an improved understanding of the music composition process (Padberg, 1964).

In 1959, Hiller and Isaacson published their research findings in algorithmic composition in the "Experimental Music: Composition with an Electronic Computer". A book review of the same year by Peter Westergaard suggests about the methodology followed by their experiments with the computer. Accordingly, the characteristics of sound such as pitch, timbre, dynamics, and rhythm were represented as numeric numbers while their relationship (for example, interval for the pitch) in terms of arithmetic operations. The laws governing a particular music style were formulized into operating instructions. The computer applied them to the numerically represented characteristics with the relationships defined by certain operations. Various governing principles including restrictions were applied in a range of experiments to obtain the desired music. In the initial movements, the restrictions of first species counterpoint were applied. The third experiment focused on timbres, dynamics and rhythmic patterns, while applying a governing law to prevent two successive skips for melody and ensuring proper resolution of tritones for harmony. The fourth experiment was conducted based on the Markoff chain principles, where the likelihood of each successive note in a line was impacted by the weighted probabilities assigned to the interval between that note and another. The other note usually was determined as the preceding note or the first note of the corresponding

section. Ultimately, the Monte Carlo method was employed to generate music where computer produced a set of random numbers, and operating instructions were used to determine the characteristics that aligned with established governing laws. Accordingly, compatible numbers were recorded onto an output tape and subsequently decoded into musical form. The experimenting researchers, who also authored the book, emphasized that their endeavors tended to be laboratory research rather than an artistic production. The limitations of the experiments originated from human constraints in comprehending the music composition process, rather than from the technical limitations of the machines involved. The researchers hypothesized about certain governing laws for music composition and the computer provided a reliable platform for verifying their accuracy in laboratory (Westergaard, 1959).

Initial computer based music composition efforts manifested as scientific experiments with less emphasis on the esthetics considerations. Nevertheless, a chapter in the book by Hiller and Isaacson was dedicated to the aesthetic problem in music. The essence of music communication, and the mental and technical process of music creation were identified as main problems of music discussions throughout the history (Hiller and Isaacson, 1959).

During the middle of the twentieth century, non-numerical use of computers, that is for purposes other than arithmetic operations like for business or any other operations of interest, was rather a novel idea. Generation of computer music fell under that category of non-numerical application of computerized experiment. Although the meaning of creativity remained debatable like the meaning of intelligence or thinking, it was expected that a computer could self-sustain operation and learn from experience to act creatively. It was accepted that the early computers should not be expected to generate new music principles, whereas these had to be pre-defined to the machine in explicit detail. The uncertainty and hence unpredictability could be mainly introduced by the usage of randomization to provide freedom of choice, which was hardly sufficient to qualify the process as creative (Hiller and Isaacson, 1959).

Claude Shannon published "A Mathematical Theory of Communication" in 1948 to define a general theory of communication. His work influenced theories of information, ultimately data, and future artificial intelligence concepts that relied on it (Shannon, 1948). Communication and information theory inspired researchers from the early years of computer music composition. The paper, "Information Theory And Melody", published by the Scientific American in the middle of the twentieth century illustrates this connection (Pinkerton, 1956). Accordingly, entropy, a key concept used in information theory, is applied to notes in a music composition system. This concept is regarded as a numerical index of system disorder. It increases with the degree of uncertainty and decreases with order, as observed in organized patterns and symmetry. Higher level of entropy represents an increase in the size of the information to be conveyed in a message. On the contrary, in a system of regularity and symmetry, the size of the information and entropy would be reduced due to familiarities originating from repeated information, the redundancy. In the field of music, a melody with basic regularities and symmetry would involve somewhat redundancy to help identifying patterns, at the same time, sufficiently high degree of entropy would be necessary to introduce the level of complexity for an aesthetically interesting sound. Researchers exploring with music assumed that features of music such as melody, rhythm, and harmony could be formalized into a statistical scheme for the machines to generate music. New styles of music of any type could be created by alternating probabilities. Experiment showed that the entropy, the average information per note, was computable and provides the amount of information or expressible meaning contained by certain melodies. Quantifiable amount of redundancy or repetition were identified as necessary for achieving tuneful melodies. Rhythm ensures periodic properties that can be represented in a mathematical or mechanical way. As a result, it was suggested that machines can be built to make music by involving desired degree of entropy, redundancy, and periodicity. Early scientific experiments provided optimistic results to assume that random choices could be

in future made by the computer between melodies to select less banal music pieces among the outcomes. Information theory, hence, is considered having played an important role in studying the creative process of the human mind and in understanding the underlying principles of creativeness (Pinkerton, 1956).

According to Hiller and Isaacson (1959), music; like language, was evaluated as a discrete communication system where the basic texture could most of the time be defined through a set of discrete symbols, except for some electronic music forms. Information theory suggested that the meaningfulness of a message could be increased by restricting the number of available choices. In the most diffuse type of music, successive note selection can be easily randomized by the computer to form a basic substance. Customization, subsequently, introduces additional characteristics to the music. While generating novel music based on the known music samples, statistical methods are employed to compute the transition probabilities between the notes. Hiller and Isaacson (1959) formulized the logic of music composition into certain principles. A process of elimination was defined to select musical materials from a random environment. Certain restrictions were applied during the process of elimination to determine the range of order. The main dimension of music organization was the pitch, representing the intervals the between notes, and the time. Traditional rules of composition were used to express interactions between them. Musical coherence in a musical structure is achieved by both utilizing memory and immediate sense perception. Hiller and Isaacson recognized that setting up the proper articulation in a music structure would work according to this principle. They were inspired by the mid-twentieth century studies at the intersection of information theory and aesthetic perception of music. The perception, the attention to retrieve messages out of sounds, is considered in terms of semantic and aesthetic modes of music. Semantic mode, like language, is organized in a set of standardized symbols that are eventually coded, translated into another language, into the "score". Aesthetic mode might not be intellectually grasped, but appeal to the directly sensorial abilities at a certain limit. The term "acoustical quanta" was defined by Abraham Moles, to refer to the repertory of aesthetic symbols at a given scale of duration and information rate that eventually, when computed, approaches to the semantic information rate. As a result, semantic and aesthetic information in music is aligned to the same sequence of acoustical sets of quanta although captured by other means (Hiller and Isaacson,1959).

In the late 1960s, two important research papers were published at the intersection of artificial intelligence and music, the "Pattern in Music" by Herbert Simon and Richard Sumner at Carnegie-Mellon University and the "Linguistics and the Computer Analysis of Tonal Harmony" by Terry Winograd at Massachusetts Institute of Technology. The main purpose of "Pattern in Music" was to formalize musical patterns in tonal music into a language for the computer to translate descriptions into musical notations and to automatically induce patterns from scores. The describing of music composition patterns was inspired by and required exploring the cognitive activity of human music listener. On the other hand, Winogard's harmony-analysis program suggested chord labelling based on a systemic grammar model of 1960s where the system operated based on choices made from a range of options based on an entry condition. The model was designed to encode semantic options, with grammatical options serving as their eventual realizations. Semantic procedures were used by Winogard to parse the music. By the middle of 1970s, the automatic recognition of music was studied by researchers in the field. Information processing psychology and generative grammar models contributed to the development of the theoretical framework. Subsequently, knowledge-based understanding became effective in problem-solving for an intelligent music recognition system, labeled as the musical robot. The system encompassed a pattern-recognition part as well as a grammar defined for music (Roads, 1980).

The progress report of 1981, by the composer Lejaren Hiller, outlined important issues about composing with the computers. The computer-assisted composition is evaluated as a process that is hard to define, to limit and systematize. During music composition, the composer is expected to be aware of the logic behind

the creative act and to consider compositional priorities. The computer as a composing machine is equipped with algorithms to generate scores based on the initial input data, that can be enriched by running sound synthesis algorithms together with natural sound input that are converted from analog to digital, and further by adding input from the composer's own scores. The output is directed to a digital to analog converter which subsequently can be played back on an audio tape recorder. While Hiller defines his approach on computer composition, he first mentions pragmatic concerns; that is the music in the end should be performable and the performance would be a test of the outcome. A notable feature of the approach is its emphasis on probability and statistics. His music, as Hiller describes, tends to proceed from dis-order to order. The process is initiated with random generation of musical elements and is being progressed by the application of increased number of constraints on the elements' acceptability. Hiller admits the influence of information theory on his own approach. To preserve the creativeness in the music composition process, he does not recommed the heavily use of deterministic algorithms relying on mere data transformation (Hiller, 1981).

Hiller's report further provides information about the algorithmic approaches used in music composition following the introduction of Illiac Suite for String Quartet. The Computer Cantata of 1963, for example, employed basic problem solving computer implementations mainly based on statistics and stochastic processes. The composition of the HPSCHD piece in 1968 was based on three sets of computer programs; a computer program for composing and producing sound by means of digital-to-analog conversion, another one for composing harpsichord pieces that are derived from Mozart's Musical Dice Game, and a final third program for creating a performance part that was prepared for a commercial phonograph recording by the human composers. The basic note generator that was utilized for the composition was a subroutine in the name of ICHING, that recreated the Chinese Oracle of the Book of Changes, and generated products based on a polynomial distribution. These examples provided by Hiller strongly suggests that stochastic models were used in the twentieth century computer-based music composition. The models incorporated a randomization element to facilitate experimentation with machine creativity (Hiller, 1981).

In the beginning of 1970s, Experimental Music Studio (hereafter EMS) was established by Professor Barry Vercoe at the university of MIT to dedicate research on computer music. Real-time digital synthesis, live keyboard input, graphical score editing, programming languages for music composition and synthesis were focal areas of research. The paper "Machine perception of musical rhythm" was also published at EMS in 1975 and an intelligent music perception system was developed to automatically recognize and record meter, tempo and note duration during the live performance of a musician. A breakthrough in computer-based music research emerged in 1980 by David Cope at the University of California, Santa Cruz when they developed "Experiments in Musical Intelligence" (hereafter EMI). This work was groundbreaking by shifting away from giving the computer a list of rules and introducing the composer's style to the computer to analyze and emulate. The EMI utilized corpus-based methodology and augmented transition networks adapted from natural language processing. The system was fragmenting existing music and recombining pieces thereby creating novel music of the original style (Verma: 2021, Chen: 2024, Wang: 2024).

The methodologies dominantly employed in computational music generation are organized into various core paradigms ranging from stochastic models like Markov chains, frameworks of formal grammars, heuristic rule based systems, genetic algorithms to more recently applied approaches of the Neural Networks and Deep Learning, alternative Chaos theory based models to self-similarity systems and agents based systems (Carnovalini and Rodà, 2020). This study illustrated Markov chains, frameworks of formal grammars, rule based systems as dominant methods used in the twentieth century experiments. Artificial neural network-based music generation emerged in the late 1980s. The development of deep learning techniques influenced over the time computer music generation similar to other creative work domains. Critic exists however, due to the black box nature of systems working based on machine learning, it is hard to evaluate

the underlying functioning of the generation process and the usage of dataset and ultimately to control the piece produced by the system. Genetic Algorithms employ a combination of solutions to generate new ones based on a random set of initial solutions and work by selecting better fitting answers to evolve into the optimal solution to the original problem. Specification of a problem remains a challenge, however, genetic algorithms have been used in the implementation of music generation systems, with well-known examples dating to the 1990s. It is noted that these methods are used in a hybrid way, for example by using Markov chains in generating initial population, evolving grammar rules or parameters of a Markov chain and incorporating neural networks or human assessments in the fitness function for the genetic algorithm. Self-similar systems, on the other hand, have been used to generate musical material which serve as inspiration to human composers. This is mainly possible due to the nature of music compositions containing certain degree of repeating patterns and variations in the musical structure and spectral density. It is emphasized that these systems are based on chaotic and random decision making processes and due to lack of their aesthetic value are less interesting to AI practitioners. Nevertheless, they provide means to explore unconventional melodies. Ultimately, agent based systems provide a modern approach and a meta technique rather than a specific algorithm for music generation. The agents, autonomous software with perception and action abilities, can cooperate and act as part of a multiagent systems. Various autonomous agents in a system generate improvised melodies according to an algorithm while production is being regulated according to a behavior model maintaining a general agreement between the agents (Carnovalini and Rodà, 2020).

Technological advancements and novel AI techniques as applied to various field of research contributed to the sophistication of computer based music generation simultaneously. Machine learning, in particular deep learning models such as Generative Adversarial Networks (hereafter GANs) and Recurrent Neural Networks (hereafter RNNs) play an important role in the contemporary implementations. Using computer-based methods provides advantages in the speed and scalability of composition and supports the composer in experimenting with unfamiliar elements introduced by AI. Furthermore, easy access to tools and methods, and the cost efficiency of their usage make automated music composition attractive for the producers. Eventually, the use of AI in the creative industry is impacting music production processes and the overall experience of the audience (RaNa, 2025).

Synthesis and critical observations

The investigation of the historical trajectory of machine creativity highlights a transition from early inquiries preoccupied with the originating subject of the creative act towards the systemic imitation of the creative process itself. Lovelace was challenging the unpredictability of computational creativity dependent on the human origin. Turing, on the other hand, advocated for a method for evaluating machine intelligence based on the observable outcome. The assumption that creativity must remain inherently subjective was diminishing. Modern perspectives treat creativity as a process-oriented phenomenon that can be implemented by a computer with visible end products in terms of ideas or artefacts rather than a hidden, individualistic attribute.

Historical records indicate that the foundational instances of computational music composition emerged during the nascent stages of artificial intelligence. This survey focused specifically on the mid-twentieth century to examine the origins of these experiments, operating on the premise that the traditional algorithmic methods prevalent in early implementations offer significant insights into the formal definitions of the creative process as conceptualized by researchers of that era. Historical analysis showed that computer music composition used information theory as theoretical framework. This context was identified through a synthesis of historical account and original text. In the mid-twentieth century attempts, mathematically

based methods, stochastic and random algorithms were implemented. Grammar models were adapted in building theoretical framework. Researchers in the field utilized mathematical models and statistical data-based calculations. Governing rules, based on music theory, were defined and blended in random combinations. The basic elements established in music theory, such as harmony and rhythmic structures, were defined into algorithms to produce novel compositions by the computer. Rule-based knowledge systems and grammar models were subsequently applied during the twentieth century. Modern AI approaches introduced data driven machine learning models that have been utilized in various fields including computer based music composition.

Drawing upon a synthesis of existing literature, Carnovalini and Rodà (2020) suggest that music allows mapping to precise mathematical and computational models in a more streamlined way than other artistic media like poetry or figurative painting eliminating complexities of semantic interpretation from the creative equation, thereby constituting a fruitful field for computational creativity studies. While this finding due to the inherent structure of music is remarkable, it is important to also note that computational creativity in music is nourished from the advancements in the other fields of creative art. A recent study by Chen et al. (2024) illustrates this by the implementation of a single computational framework that simultaneously generates images and composes corresponding music. This is enabled by spectrograms as visual representation of sound and the application of sophisticated machine learning algorithms such as GANs that originated in the applications of computer based visual art studies rather than music composition work (Anantrasirichai and Bull, 2021). Carnovalini and Rodà (2020) also suggest that existing reviews in the computational music generation systems widely focused on technical methodologies over theories evaluating machine and human creative processes. The understanding of the nature of creativity itself by the study of computational creativity remains an open field to further research.

Existing literature review indicated that social scientists in the computational creativity field tend to examine the creative process itself whereas artists are looking for a way to collaborate with AI to amplify their own creativity. While this provides valuable insight, it is essential to acknowledge that the boundaries between disciplines within computational creativity are not sharply defined. Practitioners frequently operate across multiple domains rather than working in silos; for instance, a composer may also possess mathematical expertise or engage in close collaboration with computer scientists. This pattern has remained valid since the early examples, as observed by the pioneering collaborative work of Hiller and Isaacson. Consequently, research in this field is characterized by an inherent interdisciplinarity that resists rigid categorization. Moreover, historical records of twentieth century, explicitly in the example of Hiller and Padberg, showed that in the early efforts of music composition, the artists were more concerned with an improved understanding of the music composition process rather than the artistic value of the resulting work by the computer. These early endeavors remain significant, as they provided foundational insights into the creative process through the specific lens of musical composition. It is plausible to attribute these outcomes to the nascent state of algorithmic capabilities at the time, which was characterized by relatively modest artistic objectives with the help of technology. As technological capabilities and practical applications have matured, there has been a corresponding shift in the underlying motivations of researchers within the field. An example of this changing perspective is captured in a statement by David Cope where he described the motivation for developing his EMI project as a direct response to a personal creative crisis. Subsequently, he was looking for a computational "composing partner", also reflecting an early indication of that computer was becoming a collaborative partner for the artist, rather than being used merely as a tool (Pearce et. al., 2002).

Conclusion

This research delineates findings of an analysis that focused on mid-twentieth-century computer-based music composition experiments and how systematic imitation of the artistic novelty provided insights into human creative processes.

The interaction of artistic creative endeavors with technology gained a renewed dimension with the emergence of computers in the mid-twentieth century. During this period, algorithmic music compositions experiments with the computer were initiated. Composers who were experimenting with the formal definition of the music composition process used the computer as a laboratory environment to define, run and refine their algorithms. Common objective of the practitioners was to understand the methodical process of music composition. The production of creative work with artistic value was not central to the initial experiments with the computational tools. This approach evolved over time and the artist utilized computer as a collaborative partner in supporting and enhancing the human creative process. In the recent studies in computer based music, human-AI co-creation is emphasized as a dynamic, iterative partnership diverging from the simple automation and delegation of tasks. AI, accordingly, does not replace human creativity but transforms it by adding a strong collaborator. It introduces new questions, forcing new perspectives on the existing structures and experiences. Ultimately, the evolution of novel composition is driven by the dynamic interplay between human interpretive adaptability and computational variance (Wang, 2025). In this context, higher acceptance of AI technology correlates to higher levels of creative productivity (Ma, 2025).

Contemporary literature highlights several current and future challenges in the computer music generation. Originality of the work, legal issues in terms of authorship and copywrite ownerships, and the cultural bias introduced by training AI mostly on Western-based music forms are problematic topics in the field (RaNa, 2025). Further challenges involve the controlling of the generated output of the systems, adding the sense of emotions to the produced piece by the automated system, the complexities in utilizing hybrid approaches, obtaining quality of the audio in the outcome, the generation of longer pieces of music by structuring, choosing appropriate representations for the musical content, and adapting the difficulty of the output to be played by a human (Carnovalini and Rodà, 2020).

A recent study by Rohrmeier (2022) highlights that music creation requires general artificial intelligence capabilities making it an AI-complete problem. This is based on the inference that music making requires a cognitive model of music as it exists within the human mental sphere. The cognition furthermore depends on the biology of the body. Accordingly, models of body, instrument and settings impact the overall composition process. Music creation requires also non-musical references in the external world, for example a model for inhabiting the sound and motion dynamics of external world objects. In addition to these, musical artificial creativity contains the meta-creativity challenge. This involves higher-order concepts in musical composition techniques and forms such as Mozart's creative composition idea using the musical dice game. Applications of musical quotations and allusions as triggered by semantic or pragmatic purposes fall within the complexities inherent in the generation of music by the AI.

The generation of expressive music is identified as one of the main issues of AI in music. Neural networks remain the most widely utilized approach in the current applications, while state of-the-art solutions derived from other fields are adapted for music generation. The study domain contains human-centric problems including the objective evaluation of the produced pieces and assessing the expressive quality of AI music. The potential of artificial intelligence to surpass human intuitive capacities and achieve autonomous artistic agency remains an unrealized goal in contemporary computational creativity, marking a significant challenge for the future research (Mycka and Mańdziuk, 2025).

Our study examined the contributions of computer-based music composition work to the overall understanding of human creativity process through a historical review. The result of the research showed increased potential and interest in enhancing individual creativity with the integration of AI as a collaborator, thereby implying renewed definitions of creativity for future.

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