Can Computers Write Meaningful Music?

yilin.zhu@mail.polimi.it

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Abstract

This thesis discusses whether or not computers, or the definition of computational creativity, are able to create meaningful music. It talks about the concept of the program in solving music composition problems, followed by a discussion on how to reasonably judge the results of those computer-generated music workings, including a definition of creativity, and how human bias affects evaluation. Several pieces of literature and historical examples are cited as supporting material. Then the essence of meaning is speculated after clarifying the emotional expression in music composition to achieve my final conclusion which is: yes, computers can write meaningful music. This is the final thesis for the course of *Philosophical Issues of Computer Science* in Politecnico di Milano 2019 - 2020.

1 Introduction

With the rapid development of academic research and industrial applications in recent years, intelligent systems have been widely applied in multiple fields, even in the field of artworks. Not only in painting and writing, computers have proved themselves to show their capabilities by solving higher-demanding works as composing a piece of music independently. While the field of Artificial Intelligence has grown and become mature, more programmers and music producers have succeeded in making different intelligent systems. At the same time, there comes the question in the field of computational creativity: **Do computers really have the ability of writing meaningful music or not?**

There are a lot of doubts about computational creativity since the beginning when programmers and musicians did experimental music generation using the computer. Some early music pieces are made, but they are strange or irregular and are tagged as computer based experimental music. Later on, more advanced methods are used in computational music composition. Brilliant works made by computers can not even easily be distinguished by professional musicians. The borders between human works and machine compositions are not solid anymore, but the results keep enlarging people's doubts on the definition of art spirit or its "meaning" deeper inside a music piece. Even though some computer-composed works show almost no difference from the perspective of music appreciation, compared with human works, people still hold deep doubts on the results of computer generated music. They don't believe that machines are able to make meaningful works as humans do.

My argument is that computers can make meaningful music. The main reasons for my argument are shown as following,

- Computers do not only do what they are programmed to do. They can do things beyond human expectations and limits.
- People usually have a human bias against computer composers. A good way to avoid this prejudice is judging from the perspective of listening and enjoying musical composition works, rather than judging the composer (computer or human).
- A computational composition built on the software level can give innovation power to break the existing rules.

In this thesis, I am going to argue on some common opinions and easily mistaken definitions in programming and creativity. In the following sections from **Section 2** to **Section 4**, I will elaborate on the reasons for my discussion to support my argument. Then in **Section 5** I will talk about how I come to the final conclusions that computers can make meaningful music.

The purpose of this thesis is to review some common opinions and display my thoughts on this topic. Since the topic of computational creativity in music composition stands between the interdisciplinary subjects of computer science, computational creativity and art, the relevant articles I will cite are scattered across different journals.

2 What is programmed in a program

There are common beliefs that computers are not supposed to have creativity since they only know how to solve problems following pre-programmed procedures. I don't agree with this opinion on the premise condition of computational creativity.

As it was stated early on an article in (Minsky, Marvin, 1967)[8], the author points out that "*This false belief is based on a confusion between form and content. A rigid grammar need not make for precision in describing processes.*" (Marvin Minsky 1967, 1)[8]. It is clear that the programmers set the rules for the program itself to solve a problem by executing the procedures according to the ruleset, but a program does not always provide answers in a predictable manner.

First, a programmer should have particular results in mind in order to write clear code for execution. They must be able to imagine or have full sight of a figure of the final results. In other words, one must be able to see the range of computer performances and the respective outcomes of the program. But the more the computer has free space in deciding the procedure over the basic rules set, the looser the definition in specifying the program would be for the programmer. In this sense, the programmer serves as the rule maker or a conductor from a higher level, while the computer would be the actor and player inside the outline, who does the actual performance within the left blank space.

2.1 Vague Problem

In order to describe a problem to be solved in a computational way, the programmer needs to follow a rigid grammar to describe the procedures for computers to execute. However, the left space is totally free, which is between the definition of the problems and the precise procedures to be followed.

For the programmer, some uncertainty still remains about the middle stage of how to solve the problems, which remains the searching space for the program to discover by itself, as long as the program does not step out of the range set by the programmer. On the other hand, a programmer does not even have a certain idea of how the program would execute and how it would proceed in every step. That's the reason why I can not agree with the opinion that computers can only do what they are instructed to.

Actually, in the area of music composition, which is a form of art working, we ask the computer to solve a mostly vaguely defined problem. Some programmers want the computer to give the answer to specific questions like, "make some Jazz improvisation", "make a pleasant melody", or "make some Bach style composition". The answers to those questions would be pieces of music meeting certain conditions, like both the results and the procedures to satisfy such searching problems.

One famous example of computer-generated music is the system named *Experiments in Musical Intelligence* made by David Cope. In his experiment, his computer program is able to analyze existing music from past composers, and, by generalizing, give similar but novel musical compositions in the same style. Another example (Assayag, 2010) [1] should be mentioned is in making jazz music. It is focused on the process of improvisation and the cognitive demands of a music agent. The program can reason about time, remember and conceptualize what has already been played, and it can do the planning ahead for what might be played next.

2.2 Unpredictable Answer

A number of such music generators can be found in recent research results. As summarized in another article (Fernández, Jose D and Vico, Francisco, 2013)[4], the author brings together almost all the existing research on computational creativity in music compositions. Different methods and models are applied in the generation of melodies or rhythms, harmonization, counterpoint, and orchestration. Through the historical findings, there are six main categories of methods and algorithms used to generate music: Grammars, Symbolic and Knowledge-Based Systems, Markov Chains, Artificial Neural Networks, Evolutionary, and Other Population-Based Methods, and Self-Similarity and Cellular Automata. They are developed based on different advantages and limits in the capacity of music composition.

Among all the methods and techniques applied inside of the application, the programmer who defines the border of the problem still gives directions to the computer on how to solve the problems. They might provide some basic grammar, or rule based model, or other techniques, on how to construct single or multiple layers of rhythmic, melodic or harmonic features in Jazz Music, how to choose the instrument in the piece they would like to be used, and how to build the structure of the music composition.

Since the "puzzle" is always big and complex to be seen clearly since the beginning, so

within normal human capabilities, programmers have to leave some problem space to the computers. As the result, it is the computer that explores different ways, finishes this complex problem and gives outputs of the generated music piece, which might be beyond human expectations. Even though human programmers are able to define problem boundaries and set up the rules, they are not necessarily able to compose the same interesting music pieces as their computers.

Several authors also proposed articles on the unexpected output by computational creativity (Colton, Simon, 2008)[2] : the answer provided by the intelligent system to the original problem sometimes surprises the human programmer or the training data. There are already enough studies in this field discovering the existence of computational power in intelligent systems and algorithms.

3 Judging the composition itself

Many researchers stated that it is not possible to create art in the field of computational creativity, including music compositions. In this article (Hertzmann, Aaron, 2018)[5] , the author discussed how to observe the computer or technology while doing the creative work, and they put forward the conclusion: *"Judging the work instead"* is just a tempting way, the level of skill of the computer cannot represent their level of creativity. Even if the works made by the computer are quite impressive and good enough to be appreciated, they would still insist that *"No matter how skillful and surprising a computer's output is, we will not accept it as an artist until we infer some sort of social being inside"* (Hertzmann, Aaron, 2018, 22)[5].

I can not agree with this opinion because it shows strong resistance to computer-generated music composition. Judging the work and results of a computer is still a reasonable approach both from the definition of computational creativity and also from how we appreciate music and other art forms. I think we can take into consideration how much stimulation or enjoyment the musical pieces made by computers bring to a human audience and let them think if there are any novel and useful points inside those music pieces. We can apply this perspective as a guide to judge the creativity of computer composers. Here in the following paragraphs, I will explain the detailed reasons from two aspects, the definition of creativity and human bias.

3.1 Definition of Creativity

Early examples of this "Judging the result" method, which applied in the definition of creativity, were introduced in (Louis L. Lunsky, 1963)[6]. The author declares several principles in evaluating the creativity of a computer. Here I am citing the words from the article and we can see most of the evaluation rules are based on the results of the work the computer finished, e.g. "The answer is novel and useful", "The answer results from intense motivation and persistence", and "The answer comes from clarifying a problem that was originally vague".

Although some debates still remain unclear on how to set a most appropriate framework for assessing the creativity of an intelligent system, it is now well established from a variety

of studies that creativity can be determined from the computer-made work itself. I agree that art workings still require human intent, inspiration, and a desire to express something, but we should not use this as the reason to deny the creativity inside other non-human-made works. Otherwise, there would be no so-called "artworks" expressed by computer, since they are not mankind.

3.2 Human Bias

In the article (Edwards, Michael, 1022)[3], the author opposes another generally mistaken view that has been used to deny the existence of computational creativity, by pointing out: *"Much of the resistance to an algorithmic composition that persists to this day stems from the misguided bias that the computer, not the composer, composes the music"* (Edwards, Michael 2011, 67)[3].

Such human bias in judging computational creativity can be easily found in common audiences' behavior, as they think the computer program designed to generate music is changing the tradition from note-to-note composition to a top-down formalization of the music composition process. Here in the article, more evidence on the human bias in computational creativity has been found in a later study (Moffat, David C and Kelly, Martin, 2006)[9]. In this article, a complete survey was made for the purpose of understanding people's attitudes towards machine intelligence and creativity. They ask the human audience to listen to a list of artifacts, together with some music compositions from human composers. Then the audience would be given questions to answer (some of the questions are similar to classic Turing Test ones) in order to evaluate their attitude toward the list of music.

As it was shown in the conclusion of this survey, there is a common bias against computer made music pieces. Moreover, the bias was even stronger in musicians than non-musicians: the musicians significantly preferred the human-composed pieces. We cannot easily conclude from this study that non-musicians have a better ability to appreciate the art spirit or creativity in computer compositions. However, what is clear from this quantified survey is that human listeners do have their own preferences on whether the composer is a human or a machine.

4 The essence of meaning

The last, but not least reason I have to support my main argument is that computational composition built on software level is already giving meaning to break the existing rules. That is to say, some of the music pieces computers write are meaningful by their own existence.

On this issue, some typical confusions are included as follows: Can we believe that computers have the level of intelligence to feel and express emotions? Do they have the motivation to express emotions? Or do they have social attributes or have thoughts on society? I am going to talk about these confusions while giving examples of them, and then I will explain why I propose that we don't need to evaluate the creativity of computers from the human perspective, but by looking at the innovation in the composition and methods applied.

4.1 Expression of Emotions

When it comes to music, everyone usually agrees that music is a language to express emotions. It has been widely accepted that music is strongly combined with the expressiveness of the composer's emotional feelings. We can easily find other literature employing the same reason to argue the possibility of machine intelligence on creativity.

In this article (Hertzmann, Aaron, 2018)[5], the author claims that the current level of artificial intelligence is not mature enough in the function of emotional feeling, or in having emotional expression as humans do. So, they came to the conclusion that in the current stage, where we have no clue about how to make human-level intelligence, it is not possible to find creativity or meaning inside computers workings. I can cite one paragraph from the article: "*If we ever develop AI with human-level intelligence and consciousness, by definition, it would be able to create art, since it would have the same capacity for consciousness, emotions, and social relationships*" (Hertzmann, Aaron, 2018, 26)[5]. However, an important problem that needs to be solved in this logic chain is that: human composers cannot clearly feel what is the emotion inside their music piece until they create it, because they cannot predict it. From this understanding, the emotion expressed in the music piece is actually independent of the emotional urge they experienced or they want to express. Thus, more importantly, when talking about the emotion included in creating and composing music, we should be careful not to confuse the urge of creation with the actual emotion embedded and represented in the creation they made.

Secondly, human composers also have different abilities and purposes when expressing their intentions in their music pieces. It is common even for some famous composers that the music pieces they make cannot let the common audience understand or explain the original emotion it was supposed to have.

Therefore, from the above two reasons, the emotional expression expressed by music creation and music works is a system that is so complicated that it is difficult for humans to understand it. Neither the computer is supposed to understand the emotions from both sides (the urge to compose and express emotion in their works), especially from a human perspective that we barely understand. This is not to say human composers cannot express their feeling through music writing. But in this sense, it is not necessary to ask the computer to start music composition out of inspiration, motivation or following the urge of expressing an emotion.

4.2 Innovation Power

Different methods, models, and algorithms applied in computer composition would definitely lead to different final products. As we have mentioned before in **Section 2.2**, different approaches and models: from Grammars, Symbolic and Knowledge-Based Systems, Markov Chains, Artificial Neural Networks, Evolutionary, and Other Population-Based Methods, and Self-Similarity and Cellular Automata, all have advantages and limits. Some of the systems would start from learning from the already made human music compositions works, while others would choose to search the available way to satisfy the specific rules with testing and backtracking.

Regardless of the way these computers compose music, if the final work proves a com-

pletely new way to create music, then this method itself breaks the rules that already existed in the past and therefore has innovative value. Then we can also say that this work is meaningful. Their existence also allows human viewers and composers to appreciate this work and broadens the definition of past concepts of music composition. Thus, I would say, computational composition built on software level can give innovation power to break the existing rules.

The first representative example of computer composition is the famous work finished by Hiller and Isaacson's ILLIAC computer in 1958, which is the pioneering work in this field. They used the Markov chain in testing with heuristic compositional rules on harmony and counterpoint in a classical way. The final composition was the string quartet named *Illiac Suite*. The author of this early example said in an interview(de Mantaras, Ramon Lopez and Arcos, Josep Lluis, 2002)[7] that from the design stage, they didn't put anything related to emotion expression in the program. As a result of early computational composition, this research work is still interesting and creative as to the human audience and composers: it proved a creative and possible way to compose music pieces in this computational way. As a starting point in this research field, the existence of the results of this research inspired the computational music research that flourished after him until now.

5 Final Conclusion

I do find that computers can make meaningful music. For thousands of years, we as humans are seeking meaning from intelligent works made by ourselves. But meeting with the challenge from the advanced development in computer science, our recognition and understanding of ourselves are extended to a much larger scope. Consideration on whether or not a computer can make meaningful music is an interesting discussion in the field of computer science, artificial intelligence, and also in a music-related field. The updating technique used in this area and the blooming study in recent years are leading towards a new promising future, together with new challenges and confusion. We need to clearly understand all the concepts related, and be able to identify these confusing concepts previously mentioned in Section 2 to Section 4. Also, after citing and summarizing relevant articles, I have argued that, at least in the field of music composition, computational creativity has made meaningful progress to the human audiences, composers, and also human society. Further, the creativity they have should be evaluated properly based on their works without much human bias on the composer itself.

This paper is based on the critical thinking of philosophical problems brought by the development of computer science in recent years. Though in my point of view, after clarifying some easily mistaken concepts and mistaken common beliefs, computational creativity can make meaningful music, it still has its limit in its function, ability, or the independence of human inputs for the current stages. However, maybe soon in the future, we will surely see revolutionary changes in the maturity of intelligent systems and their abilities, which will surely update our acknowledgment to a new level and also arise risks and challenges.

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