

AUTOMATED MUSIC COMPOSITION: AN EXPERT SYSTEMS APPROACH¹

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Abstract

A review based on an introduction by Douglas Hofstadter of an automated music composition system [1] designed by David Cope of UC Santa Cruz. The system takes a series of a composer's scores and develops new works in that style. After a brief introduction to the system, you are encouraged to go to his website and listen to the musical compositions. Particularly of interest are the ones in the style of Bach, Chopin and Joplin. The concluding discussion is epistemological in nature. Emphasis is put on the imprecise use of the term Artificial Intelligence where a more precise term is available and applicable to the described system.

1 Introduction

There is much ongoing development in Computer Science that falls under the umbrella of Artificial Intelligence [AI]. However, much of this work seems to focus on specific application domains rather than on foundations that could lead to powerful and possibly intelligent systems. Few attempts have apparently been made to provide an operational definition for intelligence. The original work of Turing is often cited as a test for intelligence [2]. No attempt at the complexity of such a definition is given here. Rather, after an introduction to an Expert System applied to the field of music, a general discussion of intelligence follows.

Let's begin with a definition of an Expert System. Although the term isn't used once in the article being reviewed, its relevancy is inferred based on knowledge of the system being presented.

Expert systems – information systems that represent expert knowledge for a particular problem area as a set of rules, and that perform inferences when new data are entered [3].

An Expert System in the field of music is the Automated Music Composition system written by David Cope, a professor of Music at The University of California, Santa Cruz. The research has been titled Experiments in Musical Intelligence [EMI]. It seeks to identify musical structures based on classical music theory. EMI identifies repetitions in phrasing both at an individual score level and between multiple scores of a composer [1]. EMI uses a homologous rather than analogous approach. That is, it seeks out patterns within a domain.

¹Based on [1] Hofstadter, except for the discussion in the Introduction and Conclusion

2 Experiments in Musical Intelligence

EMI deconstructs a collection of musical scores from a given composer and attempts to write a new score in that style. Cope has been working on it for over 20 years. The program consists of around 20,000 lines of LISP code. EMI deconstructs music based on a series of criterion in such a way that it can identify recurrent themes and structures used by a particular composer. It has been noted that the compositions must be of the same general form (e.g., waltz). The program clearly follows a set of given rules in the process of analyzing and piecing together new scores. The process has been termed recombinant music by Cope.

2.1 Recombinant Music

Recombinant Music deconstructs multiple works of a composer while seeking out common themes, structures and variations. It then searches through these structures to rearrange them into a new composition while adding variations in key, note choice, and phrasing.

2.2 Syntactic Meshing

As described here this comes in two forms, voice hooking and texture matching. Voice hooking ensures that sections link together in a logical way by restricting note choices between phrases to the interval that originally occurred between the given phrases in the original piece. Texture matching allows for moving pitches by octaves and spreading out phrases in time. This looks to be primarily localized to arpeggios as a way of supporting the melodic structure of the piece.

2.3 Semantic Meshing

This involves the building of tension and its resolution. This is the heart of the system. It uses a labelling system of the five letters S, P, E, A, C, which identify the structural components of sections for a given piece of music, and are associated respectively with statement, preparation, extension, antecedent, and consequent. These labels are attached to chords and phrases within a piece to identify the current tension state of the composition. If for example, a chord in the original piece were labeled as SPACAC, then a direct match for SPACAC would be sought and inserted into the new piece, provided it follows all the rules of the system. If there are multiple identified matches then a random one is selected. However, if a direct match is not found, then we start removing letters one at a time. In this example if we find no direct matches, then a new search will start for the modified label SPACA.

2.4 Additional Structures

Another key to sounding like the original composer is found in signature riffs. Musicians have a tendency to repeat riffs using different notes with the same intervallic pattern across compositions. The system is weighted toward pure interval matches but doesn't restrict itself only to pure matches. For example, an interval pattern of the notes BCACGCF#C would directly match EFDFCFBF. (I chose this in particular for those musicians that recognize this classical riff). The key here is that the match must occur between and not within the same piece. Otherwise we may be dealing with a standard motif present only within that piece.

The system is finely tuned by controllers. The goal is to find the optimal number of signature riffs by the composer. This is done in part automatically. However, too many or few of these riffs is not ideal for recreating a piece in the style of the composer. Therefore, some manual configuration adjustments may need to be made to these controllers to identify an appropriate number of quality signature riffs.

3 Discussion

Artificial Intelligence is a branch of Computer Science. However, the term can be a misnomer when applied directly to a system that doesn't truly display intelligence beyond that information which it was programmed to process. We would prudently circumvent a variety of misconceptions by referring specifically to the area of AI at the core of each respective system. Are these misconceptions based on the sensationalism that has been attached to *artificial intelligence* in science fiction over the years?

A definition of intelligence seems appropriate to this discussion. There is a very small variety to choose from as it has yet to be fully operationally defined. Quite often what has been dubbed the Turing Test [2] is referenced. Sternberg's triarchic theory of intelligence is sufficient here. It is composed of three major aspects: analytical, creative, and practical thinking [4]. If a system can progress to the point of making analogies, massive inroads would be made toward a general Artificial Intelligence. Many things can be known through analogy. "Analogy is (1) similarity in which the same relations hold between different domains or systems; (2) inference that if two things agree in certain respects then they probably agree in others [4]."

Clearly EMI doesn't figure out anything more than what Cope has encoded EMI to identify. He set up the rules for the program to follow. I am thoroughly impressed by the results. However, it seems quite misleading to even remotely imply that EMI is intelligent. Even Cope himself [7] has described it as an expert system. Hence the use of the term AI in such a way only furthers misconceptions about the field. The use of precise terms such as *expert systems* or other variants within the field as appropriate do not necessarily hold similar implications.

This misnomer in AI could be circumvented somewhat by terms such as *encoded intelligence*. But it would likely be insufficient for AI. It is in no way being suggested that we change the name of the field but rather that we be cognizant of the presuppositions contained therein. A term such as *encoded intelligence* would hold that:

A particular *Manifestation of intelligence* would result from *direction* by or *transfer from* some source intelligence(s) and would be limited by the source domain(s).

This term has been presented here just to illustrate a point. Namely this definition is insufficient when it contains suppositions those aren't identified or necessarily supported. The definition contains presuppositions and a basic worldview. I particularly like McCarthy's statement that "AI research not based on stated philosophical presuppositions usually turns out to be based on unstated philosophical presuppositions" [6].

At first sight this article seemed sensationalistic. Upon further reflection I have concluded that the credibility of AI has experienced erosion from the sensationalistic mediums through which it has been portrayed.

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