CURRENT AND FUTURE DEVELOPMENT OF RESEARCH IN MUSIC BASED ON PARALLELS WITH NATURAL LANGUAGE PROCESSING

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ABSTRACT

Modernism has affected all of the arts with its core value of subjectivity, which distorted the objective basis of aesthetic judgment. Literature was impacted the least, fine art was substantially impacted, and music has been completely dominated by it. Music composers originally wrote compositions by hand to express themselves. Since the discovery of artificial intelligence, computer scientists discover how to create a program that will help music composers write their compositions. The hypothesis of the paper is that the domain of Natural Languages Processing (NLP) resembles current research in music so one could benefit from this by employing NLP techniques to music. In this paper the similarity between both domains is described. The levels of NLP are listed with pointers to respective tasks within the research of computational music. A brief introduction to history of NLP enables locating music research in this history. Possible directions of research in music, assuming its affinity to NLP, are introduced. Current research in generational and statistical music modeling is compared to similar NLP theories. The paper is concluded with guidelines for music research and information retrieval.

1. INTRODUCTION

When a music composer manually writes music compositions, he has reason the intention in his music as well as his creativity. Computer scientists have newer approaches to writing music compositions by generating programs as technology improves. Along with the information revolution triggered by the introduction of computers, new opportunities have emerged for music artists and researchers. When some began executing computational problems on large mainframe computers others used them to generate early computer music. At this point of time one started to think how computers might be used to process and analyze music matter. Music, similarly to human speech, accompanied human evolution from its beginning, so deep understanding of music can allow better understanding of better human cognition. However, music data is in most cases still treated as unstructured binary data left on the same shelf with images, movies, computer programs; opposite to textual data, which are easy to process, search, index, driven by a large number of available computer aided techniques provided by natural language processing, information retrieval or text data mining like classification, analysis, generation, summarization, indexing, searching, translation and much more.

2. METHODS

The strategy for creating a program that writes music composition involves many procedures and challenges. An existing programming language to develop a library that stores common music structure operators. The difficulties in creating music composition automatically using artificial intelligence techniques are related to the complex semantics and syntax of how music is created in the brain as compared with how the same music can be represented programmatically. Therefore, a programmer must choose an appropriately capable programming language that can support the required music structures.

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3. CREATIVITY

Although music programs can compose music of a relatively sophisticate nature, they require creative input from both the human composer and the computer scientist or programmer. The creativity has two forms: the composer either has originality or borrows from existing ideas. The creativity part of computerized music composition is very challenging because there is a lack of technology that can adequately quantify and implement human creativity. Some Music Composers and Programmers argue that the human composer must handwrite his music compositions because computer program lacks creativity. The composer needs to dedicate his time to creating compositions as well as the programmers' dedication to create efficient and stable programs. Since technology improves every day, the music programs have better algorithms and programming languages.

4. MUSIC AS A NATURAL LANGUAGE

By definition, a natural language is any language which arises in an unpremeditated fashion as the result of the innate facility for language possessed by the human intellect. Not everybody agrees that music fits this definition, but music researchers, who know the rules of music, are usually more prone to agree with it. Music, as well as text, has the symbolic representation that has its origins dated back in ancient times. Music and language are the only old human creative activities where symbolic representation is commonly used. Others, like painting, sculpture, dance did not have such common symbolic notation. Music notation cannot be directly ported into computers like text is, but this is only a representation issue that could be easily overcome. For instance, the argument that text can easily be split into words - the basic features for Natural Language Processing (NLP) and Information Retrieval (IR), which is not the case for music, can be countered if one mentions that there are natural languages that do not use anything to separate words, like **Thai**. However, music can be treated as a natural language and could be processed in the similar way as text. Although there are substantial differences between written text and music, they have many features in common.

NLP level	Music research areas
phonetics	Waveform analysis, audio signals
phonology	Sound events identification
morphology	Score symbols, symbolization
syntax	N-grams, shallow reduction and parsing
semantics	Harmonics, phrase level, parsing
pragmatics	Phrases, voice leading
discourse	Interpretations, context of a piece

Table 1. NLP Levels with respective music research tasks.

5. MUSIC RESEARCH PARALLEL TO NLP

In order to treat music as a natural language, one has to show that music processing works on the same classes of problems as NLP does. One distinguishes certain levels of a text processing, listed in the Table 1. NLP tries to convey the research through all those levels, from recording (a voice, speech) to understanding (the meaning of a speech). These levels also exist for music. Similarly to a natural language, music can be recorded and presented primarily as a waveform. On the 'phonetics' level one tries to investigate the structure of a sound, separate and distinguish between notes or instruments. However, music is much more complex in this area and sound recognition tasks are still facing basic problems. The second very important similarity results from the fact both domains use symbolic notations. Music

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score also consists of characters which are called notes. Similarly to NLP's morphology and syntax — music has hidden, grammar-like structure, hidden rules. Part of it is the harmony. It determines how to put words (notes) together, how to build well-formed phrases using them. It also manages the musical meaning of a piece of which the basic exemplification is a progression of chords and notes. In the case of notes and their dependencies—we may talk about the syntax of the music while in the case of chords or harmonic progressions — about the semantics of the certain phrase or given the phrasing — the pragmatics of the excerpt. This is very similar in its form to one of the main areas of NLP, which is grammatical analysis. The highest level of NLP (discourse) is also common in music in a form of ideas, desires or aspirations (romantic music) of a composer as well as pictures and actions behind it (program music).

6. GENETIC ALGORITHMS

According to T. Oliwa, genetic algorithms have a major role in computing a music composition program. They involve a process similar to the survival of the fittest, where each genetic algorithm contains a phenotype and a genotype. Genetic algorithms must work alongside a compatible programming language to produce a language that composes music. Genetic algorithms can support both originality and developed ideas, while the Konohan grammar finds the rules for sequences in music**.** The genetic algorithms randomly create a shape, which is a fixed division of the string that is divided by separators into segments. The segments are assigned by fitness functions, which determine their values from their shapes. Shapes are randomly created, so people will see different ones created during each execution. From the differently executed strings, people will see different songs being generated to suit each instrument's style**.**

6.1 GENOTYPES AND PHENOTYPES

Genotypes and phenotypes help produce an efficient program. Genotypes contain a fixed multidimensional array while phenotypes represent the music score. Using programming languages, such as the abc language, genotypes help map the algorithm for making the programs. The notation of the programming language helps describe the phenotypes, which converts music symbols into ASCII code.

6.2 KONOHEN GRAMMAR

The creativity of music composition has a major factor on whether the composer has originality or develops his ideas from existing ideas. From using genetic algorithms, Konohen grammar, and mutation, Computer Music Scientists decide to create two different entities for the pitch and duration of the music. Genetic algorithms are dynamic due to the changes in music patterns. Konohen grammar then evaluates the pitch and duration through the use of deterministic rules in music and the creativity of the composer. The convergence of the pitch and duration makes sure that the patterns do not interfere with each other. By representing pitch and duration of music composition as two different entities, the authors develop a new method for music composition.

7. PROGRAMMING LANGUAGES

When they choose programming languages, computer scientists look for reliable languages that can create efficient programs as well as a better understanding about music. The programming languages must have compatibility with the genetic algorithms to produce programs that can compose music. For Oliwa, he uses the abc language to generate music in ASCII. The abc language also produces music that is readable and writable to humans.

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Sheikholharma and Teshnehlab use a combination of genetic algorithms and the Konohan grammar to produce a program that can not only write compositions, but also has originality.

8. RELATED WORK

Current research in music concentrates around Music Information Retrieval, both for the signal and symbolic music representations. In most cases it deals on basic issues how computers should deal with music data in general. The level of music interpretation does not go into semantics, probably because it is vague what the meaning in music is. However, one should notice that current text Information

Retrieval benefits from the semantic layer of text (text classification, ontologies and relations between terms, dependencies between documents, linguistic layer of text). We would like to emphasize the work of Lerdahl and Jackendoff , who first describe a generative approach that one can use toward the music. They describe it in a computational linguistics manner, using preference rules approach, mentioning that it could be possible to implement their rules in a working system. For the implementation of their system we had to wait for a long time, since they did several elisions of some tough to define, important basic notions, understandable by humans, but hard to implement on a machine. A recent try deals with all the implementation issues by introducing several important limitations to the system, which does not go beyond syntactic level, leaving behind harmony issues. Probabilities and corpus based statistics is an inherent part of all modern NLP theories hence probabilities can model the meaning of text by inferring dependencies within it.

Statistical analysis is a very important component of NLP models and it has played and will play a major role in music research. In many cases, solutions to many problems that gave good results for texts, could give comparable results in music area. As an example, the n-gram method of authorship attribution developed for natural language texts gave good results for composer recognition of musical pieces.

9. FUTURE OF MUSIC RESEARCH

If the hypothesis that NLP and current computational music research are in a sense the same but operate in two similar but not identical fields, both fields could benefit from this legacy. For instance, applications that span large number of levels of NLP (e.g. try to draw some high level conclusions based on low level music representations) would work better, if they focus on a few levels only. As we have pointed out the layers of NLP, some of them are not that well covered for the music matter. Lots have been done in the areas of music ‘phonetics’, ‘phonology’ and ‘morphology’. We notice some recent work in the area of ‘semantics’ but there is no models in higher, much more interesting but complicated levels: ‘semantics’ ‘pragmatics’ and ‘discourse’. Those areas define the meaning of the data we deal with, the understanding of undergoing structure and the flow of composers ideas within a piece. In general, one can stack different applications given the structure of NLP i.e. the output of a model that operates on syntactic level could be an input of a model operating on semantic level.

A few tasks that are relevant for music research and are well developed within NLP are sentiment analysis, genre classification, automatic summarization or idiom extraction. Other approach would be to enhance MIR with some semantic aspects of music matter - music ontologies with an application of shallow parsing (or alternatively, local reductions) to reach the level of current state-of-the-art of textual Information Retrieval. However, it is still not clear how to represent meaning of music in computational tasks but in this case statistical approach and data mining techniques may be relevant tool to describe this phenomenon.

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CONCLUSIONS

Because music has a diverse range, computer scientists need more research. Genetic algorithms help create form and notation of the music compositional program. The domain of music research resembles research in NLP. Both fields operate on the similar types of data that share common features. Both domains deal with data that are easily perceivable by humans but pose a lot of problems to make them fully understandable by computers. When writing their compositions to the program, music composers would need time to learn about syntax and semantics. Music composers also need patience when they convert their handwritten compositions to the computerized version of their works. Research in both areas uses similar techniques and should be able to take from each other in the areas that are more developed in one of them. Music researchers could share their insight in tasks like voices separation or boundaries detection while benefit from NLP's statistical methods, automatic approaches to semantics or aiding information retrieval and data mining with natural language understanding. It is not necessary that all those inherited techniques and approaches will work but definitely, it is worth trying.

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