Application and Study of Musical Artificial Intelligence in Music Education Field

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Abstract. Artificial Intelligence (AI) is one of the fastest-growing key technologies in the history of human science and technology in the past half-century, and remarkable achievements have been made in the fields of robotics, language identification, image identification, natural language processing, and expert systems, etc. In this paper, the status quo of the general lack of AI basic knowledge in postgraduates at conservatories of music and art is analyzed. The necessity of offering popular science courses of “Music and AI” is pointed out. The interdisciplinary research findings in the field of AI and music education are expounded, classified and summarized, and the contents of popular science course “Music and Artificial Intelligence” are proposed and described in detail.

Keywords: Music Education, Artificial Intelligence, Popular Science Courses, Content Design

1. Introduction

Artificial Intelligence (AI) is one of the fastest-growing major technologies in the history of human science and technology in the past half-century and has made remarkable achievements in the fields of robotics, language identification, image identification, natural language processing, and expert systems [1-2]. In 2017, the State Council issued the “New Generation AI Development Plan”, which clearly stated that AI-related courses should be set at the elementary and middle school level, programming education should be promoted gradually, and AI disciplines should be established to cultivate composite talents and form a highland for AI talents in China. In April 2018, the textbook “Basics of AI (High School Edition)”, co-edited by the East China Normal University Mu Class Center, Shangtang Technology, and Shanghai’s well-known high school teachers, was published. It is a textbook for high school students. The development history, basic concepts, and pilot practical applications in AI courses will be carried out in many “AI education experimental fundamental schools” in Shanghai [3]. Algorithmic composition is one of the earliest applications of AI in the field
of musical art. Early in 1956, Lejaren Hiller published an algorithmic composition work-String Quartet “Iliac Suite”, thus unveiling the application of AI in the field of musical art \cite{4}. Exploratory research on the use of deep learning technology for music creation is underway. In 2017, the University of Toronto’s Aircraft (phonetic) and other methods used deep learning (Recurrent Neural Networks) to learn from the 100-hour midi music format, and then sampled and trained. Good model to generate music \cite{5}. Due to the lag of human brain science research, the study of human activities that play a dual role in rationality and sensibility in music creation is still in its infancy. Music works created by AI are facing many urgent problems, such as the evaluation of music information, with the issue that different people listening to concerts created by AI have different evaluation results. These issues also require multi-disciplinary, multi-field collaborative studies and more considerable efforts \cite{6}.

The training content of graduate students in traditional music and art colleges is mainly concentrated in the field of musical art, with outstanding artistry and a lack of effective teaching of science and technology. The music AI science popularization course introduces AI into music education. It mainly introduces the basic ideas and methods of AI. It provides students with the most basic AI technology and related issues. It focuses on the study of AI application scenarios in the field of musical art, laying a sound foundation for further use of AI.

2. Necessity of music and AI courses
(1) It allows students to understand the current hotspots of information technology and stimulate their enthusiasm for cross-learning of music and technology. Compared with the more mature Chinese and Western music theories, the research on the integration of music and AI is still in its infancy, and many technologies need to be further improved and updated. Different research content will provide students with broad development space and explore diverse theories. And application results.

(2) It enabled graduate students of music and art colleges to have a preliminary ability to solve problems. The music major enables students to shape specific musical thinking. Using these thinking methods can handle classical music problems well. Many problems in the music field are non-linear and unstructured. These problems usually cannot be solved by simple mathematical methods or music theory. To answer, we need to cultivate students' AI-type “question-oriented” thinking mode, improve work efficiency, and optimize knowledge structure.

(3) It helps students understand the application prospects of AI in the field of musical art. AI technology has been applied in the music field for more than half a century and has achieved rich research results. Many practical music systems have been developed, such as music recommendation systems, score identification systems, and automatic accompaniment systems. Based on multidisciplinary findings, graduate students of music and art colleges should understand these representative research results and accumulate relevant knowledge of AI to form an extensive knowledge structure for future scientific research.

3. Design of music and AI course content
The teaching method of the “Music and AI” popular science course must start from music, go through technology, and return to music. You can use a problem-driven approach, such as explaining the “Turing test” issue and asking “What if you can't distinguish whether a piece of music is an
algorithmic composition or a person's working composition?” The contents of the popular music and AI courses are shown in Table 1.

**Table 1. Contents of the Popular Science Course of Music and AI**

| Lecture Series | Lecture content | Lecture Series | Lecture content |
|----------------|----------------|----------------|----------------|
| Lecture 1      | AI overview    | Lecture 9      | Watermarking and Music Copyright |
| Lecture 2      | Music retrieval| Lecture 10     | Interactive music |
| Lecture 3      | Score identification and score tracking | Lecture 11     | Sound installation art |
| Lecture 4      | Audio identification | Lecture 12     | 3D printing of musical instruments and smart speakers |
| Lecture 5      | MIDI and MusicXML analysis | Lecture 13     | Machine and virtual performance |
| Lecture 6      | Algorithmic composition and automatic accompaniment | Lecture 14     | Computer Music Research Institute and Famous Researchers |
| Lecture 7      | Intelligent Music Analysis and Music Recommendation | Lecture 15     | Computer music conferences, computer music journals, computer music websites, smart music software |
| Lecture 8      | Music emotion identification and music therapy | | |

Table 1 contains the research contents of AI in the field of music, some of which are targeted at specific music media. The music media include text, music score, audio, and sequence. There are four types of music media. For example, algorithm composition is text information to music score or music. The conversion of sequence information, text information to audio information is the research object of music retrieval. Based on digital music media, the research content of AI in the music field includes an automatic conversion among different digital music media of music works. There are various representations before and after the conversion, and different implementation methods are used for various conversion processes in different research areas.

The “Music and AI” science popularization course is based on music theory (as shown in Figure 1), using music representation media as the object, and using AI theory to study the conversion methods between music media, which involves music score identification, audio identification, and emotion. Relevant research fields such as perception, music retrieval, automatic composition, automatic annotation and music mining.

**Figure 1. Relationship between music AI and education**
(1) AI Overview: In the popular science content, the history, content, and application of AI require students to have a simple understanding, especially the development history of three ups and downs, and the main technologies and application scenarios at each stage. These main Cross-study research results in technology and music. The introduction of the relationship between AI and big data, cloud computing, the relationship between music and big data, and the relationship between music and cloud computing, so that students have an overall concept and understanding of “music and AI”.

(2) Music Retrieval: Music retrieval is a process that uses limited music information to obtain more relevant music information. By providing limited music information such as text, emotions, fragments or instances, more music information same as or similar to the music information is provided. Music information. Conventional music retrieval includes text-based keyword retrieval, music emotion classification retrieval, humming-based music retrieval, and instance-based music retrieval. The retrieval results are in the form of text, music score, audio, or sequence.

(3) Music Score Identification: Automatic identification of music score music information is a technology that uses a computer to process and identify digital music score images. It uses a digital device such as a scanner to input paper music scores into a computer in the form of images. After the image processing and identification, the music score images are automatically converted into standard music format files. It comprehensively uses the knowledge of AI, image engineering, pattern identification, MIDI technology, mathematical morphology, music theory, and other aspects.

For the editing of different categories of music by AI, it can process different music performance discipline data:

1) Boolean Type

\[ U_i \] is the i-th element in U, that is, \( i \in 1, 2, 3, \ldots, n \). \( A_j \) is the j-th element in U, \( j = 1, 2, 3, \ldots, n \). \( S_{ij} \) is the attribute value of the i-th element, and the j-th attribute. \( a_{jk} \) is the k-th attribute value \( k \in 1, 2, 3, \ldots, t \) in the j-th attribute, where t is the class number of one attribute. \( N(a_{jk}) \) is the count of \( a_{jk} \), and the dependency between attribute value pairs can be expressed by the membership function of the attribute value, as shown in equation (1):

\[
\mu A(S_{ij}) = N(\alpha_{jk})/n, k = 1, 2, \ldots, n
\]

Where \( n \) represents the data number.

2) Numerical Type

Assuming that \( l \) is the number of classes of attributes, \( C_l \) is the first class, \( N(Cl) \) is the number of attributes in \( C_l \), \( C_i \) is the i-th attribute value in class \( l \), and the membership function of the attribute value is shown in equation (2):

\[
\mu A(C_i^{(l)}) = N(C_i)/n, l = 1, 2, 3, \ldots, i = 1, 2, 3, \ldots
\]

Computer optical score identification technology can perform better conversion from paper scores to digital music, improve the speed of manually entering digital scores, and enable basic musical note input to be completed manually by computer peripherals. OMR technology provides a new way to
digitize paper music scores and has a very wide range of application prospects. Among them, computer-aided music teaching, music statistics, and construction of digital music libraries have been or will be better applied.

(4) Audio Identification: Audio is an essential carrier of information and one of the main ways of music transmission. Music information carried in digital audio can be converted into other music media. Audio identification research has a history of more than 30 years. It mainly focuses on identifying and classifying music audio and voice audio. Research objects for audio-to-text conversion include musical instrument audio identification, Chinese folk song classification and identification, Chinese opera aria classification, and music genre classification. The research objects converted into music scores (or sequence) are pitch classification identification, rhythm identification, etc.

(5) Algorithmic Composition: Algorithmic composition uses the formal generation rules extracted from the music composition theory or the work of a musician, a certain musical style, a certain musical genre, etc., and provides music by providing some necessary parameters. The process of musical information such as motivation, musical works, music accompaniment.

The audio composition is mainly based on the Fourier transform. Conventional algorithm composition methods include style model, hierarchical structure control, genetic algorithm, comprehensive control, Markov chain, music style, HMM model, mode chord dictionary library, artificial neural network, Deep learning, etc. Some of these studies imitate the composer's music style, and some focus on automatic accompaniment or orchestration. Most of the research results focus on the melody or motivation of the music to produce a complete music.

(6) Intelligent Analysis and Recommendation of Music: Music intelligent analysis is a process of searching for useful information hidden in a large number of music data through algorithms. The analysis process usually achieves the above goals through many methods such as statistics, online analysis and processing, information retrieval, machine learning, expert systems (depending on the rules of past experience), and pattern identification. Music data is vast, and a large amount of data can be used in the information age. Information mining in music big data, especially personalized music from massive music, is the leading research purpose of music recommendation. There are many different research directions according to different analysis purposes. For example, combing the music information chain belongs to music archeology. Based on the influence of musicians, the occurrence frequency of works or names can be counted to label text score images stored in image format and analyze the music style, composers' creation, habits, etc. in music data automatically. These studies should be supported by big music data.

(7) Machine and Virtual Performance. Musical Robot (Musical Robot) is a simulation machine that automatically plays music through program input (digital or mechanical). Music robots have a long history. From the earliest music box to the violin player of Toyota, they have experienced more than 200 years of development. In the world, there are piano robots, violin robots, flute robots, bagpipe robots, bagpipe robots, and marimba robots. China’s scientific research workers have conducted explorations and practical attempts in the field of gourd playing robot, dulcimer playing robot, clarinet playing robot, piano playing robot, drum playing robot, and the ethnic band playing robot.

Virtual performance is a process that uses human-computer interaction, virtual reality, gesture identification, pattern identification, and image processing to build a performance model of a specific
instrument and converts the collected performance action information into real-time music information. A well-known virtual air guitar system designed and invented by students of the Department of Computer Science of the Engineering University of Helsinki, Finland-simulates playing guitar against the air and can hear music.

4. Conclusions
In this paper, the necessity of offering music and AI popular science courses for postgraduates in music and art colleges is discussed. The contents of popular science and music AI courses are explained in detail to facilitate further course offerings.

References
[1] Emilia–Ángeles Campayo–Muñoz, Alberto Cabeo–Mas. The role of emotional skills in music education[J]. British Journal of Music Education, 2017, 34(3):1-16.
[2] Onwubiko S G . Acoustics in African Music Instrument Technology: Training the Baton Bearer for Sustenance in Music Education in Nigeria[J]. Journal of the Acoustical Society of America, 2017, 141(5):3556-3563.
[3] Juliet Hess. Critiquing the Critical: The Casualties and Paradoxes of Critical Pedagogy in Music Education[J]. Philosophy of Music Education Review, 2017, 25(2):171-176.
[4] William Michael Perrine. Bauchman v. West High School Revisited: Religious Text and Context in Music Education[J]. Philosophy of Music Education Review, 2017, 25(2):192-200.
[5] Minors, Helen Julia, Burnard, Pamela, Wiffen, Charles. Mapping trends and framing issues in higher music education: Changing minds/changing practices[J]. London Review of Education, 2017, 15(3):457-473.
[6] Hanne Fossum. From Relevance Rationality to Multi-Stratified Authenticity in Music Teacher Education: Ethical and Aesthetical Frameworks Revisited[J]. Philosophy of Music Education Review, 2017, 25(1):46-54.