Fedulova Elena Konstantinovna
Student
Research advisor: Ponomareva Elena Vladislavovna
Ural Federal University
Russia, Yekaterinburg

ARTIFICIAL INTELLIGENCE AS A MEANS OF CREATING MUSIC

Annotation*: Despite the active development of artificial intelligence and its introduction into everyday life, scientists have not been able to learn the nature of creativity, in particular, musical. However, scientists still try to make an attempt to train an artificial intelligence to create music. This article discusses some methods and techniques for creating computer musical compositions.*

Keywords: *artificial intelligence, musical compositions, computer, algorithms, network.*

Федулова Елена Константиновна
Студент
Научный руководитель: Пономарева Елена Владиславовна
Кафедра иностранных языков и перевода
Уральский федеральный университет
Россия, г. Екатеринбург

ИСКУССТВЕННЫЙ ИНТЕЛЛЕКТ КАК СРЕДСТВО СОЗДАНИЯ МУЗЫКИ

Аннотация*: Несмотря на активное развитие искусственного интеллекта, и внедрения его в повседневную жизнь, ученым так и не удалось познать природу творчества, в частности, музыкального. Однако, ученые не теряют надежду и предпринимают попытка обучить искусственный*

интеллект созданию музыки. Статья посвящена рассмотрению некоторых методов и способов создания компьютерных музыкальных композиций.

Ключевые слова: *искусственный интеллект, музыкальные композиции, компьютер, алгоритмы, сеть.*

1. Introduction

Technologies are firmly entering our lives, they are gradually developing and constantly become of greater assistance to people in their everyday lives, sometimes even exceeding human abilities. Artificial intelligence is being irreplaceable in areas, related to various kinds of computing for already a long time. However, there is an area that has long been considered incomprehensible to computational intelligence - creativity, in particular, music creativity.

Music composition and artificial intelligence have an interesting relationship that many computer scientists find intriguing. When a music composer manually writes music compositions, he has a reason and an intention in his music as well as his creativity. Computer scientists have newer approaches to writing music compositions by generating programs as technology improves. Still, artificial intelligence and algorithms cannot duplicate this type of human activity.

By its irrational nature, music is difficult to algorithmize; majority of people are still convinced that computer algebra and music harmony are absolutely incompatible things. However, these areas have much more in common than it might seem at first sight. Dutch masters of the old style had associated the form (based on calculations) of their works with the symbolism of certain numbers, Bach has the same. Tchaikovsky believed that any good music is programmatic. Beethoven's Sixth Symphony and Tchaikovsky's Manfred Symphony are classic examples of program music. Progress does not stand still, and scientists made a big leap towards the creation of fully computer music.

In this article, the following approaches to creating computer musical compositions will be considered: using the generation of musical forms and using a structure that uses sustainable distribution, a recurrent neural network with short-term memory and genetic algorithms.

2. Musical forms for generative music

Our direct perception of music is only its surface: the relationship between single events, such a melodic phrase, a given chord, a drum beat or signal processing when recording sound. So, the form is the result of structural relationships between different musical elements.

There are several methods for applying forms to generate music:

- Top-down approach is an approach in which you can add structures and surface elements to standardized forms.
- An upward approach is the opposite to the previous one. It is to allow the material to determine its use: the form of the material.

Let's consider these approaches in more detail:

2.1. Bottom-up: Perceived Structure through Self-Organization

To create such a structure, attempts were made to create a form of improvisation. For this, a mechanism in which individual formal structures were generated that ensured the density and goals of the activity during the work was developed. These structures constantly adapt depending on how they perceive the developing environment.

2.2. Top to bottom: architectural models of the structure

The adoption of a more architectural approach in generative music required the prior generation of formal structures to varying degrees. Formal repetition is the first structural element generated using the Markov model, extracted from the music of the example, followed by filling in the surface elements. Due to the clear repeating phrases found in the original styles, the GESMI forms (Eigenfeldt 2013) are plausible [1].

3. Musical composition with a recurrent neural network

Creating a musical composition with a recurrent neural network will be considered as an example of a structure for musical composition based on sustainable distribution for training a repeating neural network.

For this method, the standard structure of long short-term memory is used (Fig. 1).

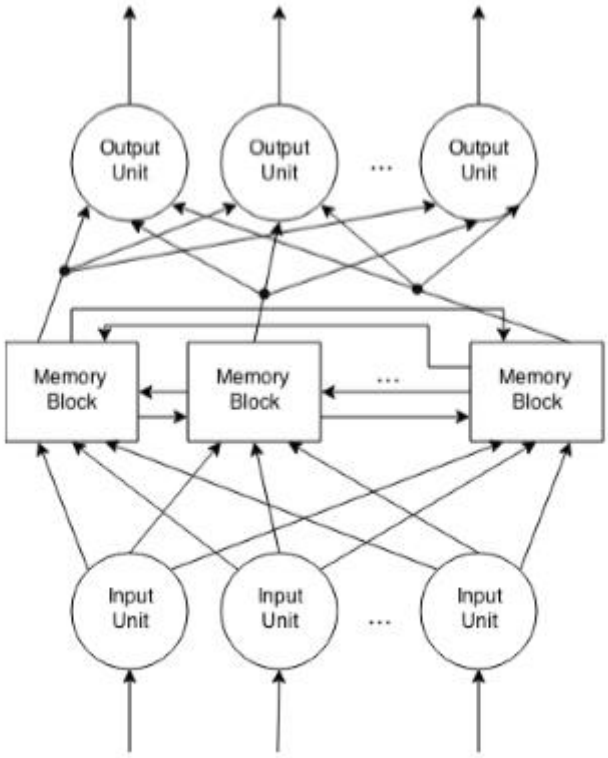

Fig. 1. Long Short Term Memory

The network has one fully connected hidden layer of memory blocks, which contains one or more blocks (memory cells). The memory unit also contains three sigmoidal gating devices: input, output and forgetting. The input gateway learns to control when the inputs are allowed to go into the cell in the memory block, so that only the corresponding content is stored; the output gate learns to control when the cell output should be transferred from the block, protecting other blocks from interference from the current inappropriate memory contents; The gate of oblivion learns to control when it is time to forget the already remembered value, that is, to reset the memory cell. The outputs of all memory blocks are periodically returned to all memory blocks to «remember» past values [2].

The presented network is based on the principle of short-term memory. The training is performed using elastic propagation, i.e. heuristic optimization algorithm. This method in some extent is a training strategy with local adaptation aimed at alleviating the problem of training with gradient descent by changing the parameters specific to weight.

As a result, the system consists of two phases: the training phase and the test phase. First, several musical compositions are sent to the network discussed earlier, and then the network studies them using a recurrent neural network and stable back propagation. The purpose of these phases is to predict the output probability for each note that appears.

4. Genetic algorithms

Genetic algorithm is a heuristic search algorithm used to solve optimization and modeling problems by sequentially selecting, combining, and varying the desired parameters using mechanisms reminiscent of biological evolution. It is a type of evolutionary computation. A distinctive feature of the genetic algorithm is the emphasis on the use of the «crossing» operator, which performs the operation of recombination of candidate solutions, whose role is similar to the role of crossing in wildlife. To some extent, they are also equipped to create and change forms, as described earlier.

Genetic algorithms randomly create a form, which is a fixed division of the string, which is divided into dividers into segments. Segments are assigned by fitness functions that determine their values by their shapes. Shapes are created randomly, so people will see different ones created during each execution. From different strings performed, people will see how different songs are generated according to the style of each instrument [3].

Conclusion

In this paper we focused on approaches to generating computer music. This area is actively developing and is increasingly used in industries such as education, online games, cinema and others, where music plays an important role. And, although at the moment, humanity has not been able to train computers to independently generate music and human participation in this process is still necessary, it is likely that in the near future, artificial intelligence will be able to replace humans in this field.

REFERENCES

1. Eigenfeldt A., Bown O., Brown A.R., Gifford T. Flexible Generation of Musical Form: Beyond Mere Generation/ ResearchGate. 2016. 8p. Режим доступа: https://www.researchgate.net/publication/306206426_Flexible_Generation_of_Musical_Form_Beyond_Mere_Generation (дата обращения: 13.12.2019)

2. I-TingLiu, Bhiksha Ramakrishnan. Bach in 2014: music composition with recurrent neural network / Cornell University. 2014. Режим доступа:

https://arxiv.org/abs/1412.3191 (дата обращения: 15.12.2019)

3. Tran V. Music composition using artificial intelligence. 3p. (дата обращения: 15.12.2019)