Extended Abstract

Music and Network Science

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Introduction

Music is an important component of the information society. It is known that music can render both positive and negative influence on human being and society. However mechanisms of this influence in many respects remain unclear. Network science application to the analysis of pieces of music is an effective approach of modern cognitive technologies and can play an important role in understanding not only problems of music and other kind of information impact on a person, but also other global problems facing of the present society.

The reductionism as research method dominating in modern science, assumes that the studied system can be understood if properties of its elements are described. Music belongs to number of so-called complex systems which don't manage to be described and understood formally by means of such approach.

Methods

Since the end of the last century for studying of complex systems the new effective instrument of research - the theory of complex networks [1] have been developed. Nodes in such networks represent elements of these complex systems, and links between nodes – interactions between elements. Such

networks form a peculiar backbones of the relevant complex systems that allows to model such systems in general as a whole and to overcome some shortcomings inherent to a reductionism.

Results and Discussion

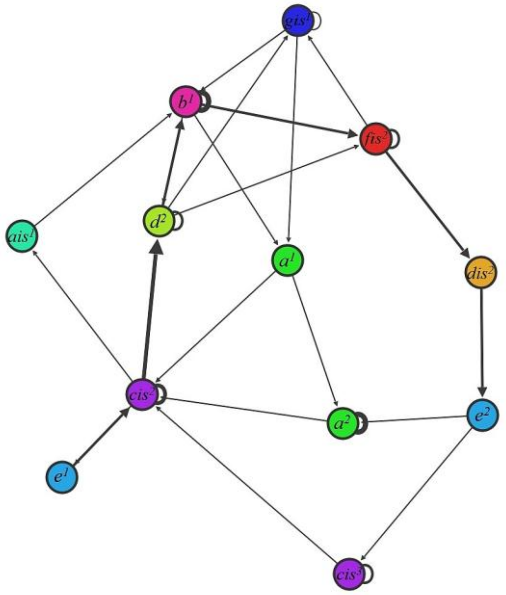
The purpose of this presentation is to show that works of music can be described as multilayer networks, which structural and dynamic properties can throw new light on the nature of music as complex system.

A musical melody can be easily converted into a network structure if we take the musical notes of all possible durations as its nodes. It can be easily calculated that the number of nodes in one voce in such network shall not exceed 1800. Indeed, the number of piano keys equals 88; if we multiply it by 20 – the number of all possible time durations of notes (halves, quarters, eights e.t.c.) - we get the number of 1760. Connections between nodes (notes) in the network are established according to chronological principle: if note I starts to sound at the moment in time T, when note J at this particular moment finished to sound, there is a connection between the respective nodes of the network [2].

In our approach the same notes in different octaves belong to different network layers. On an example of " Prelude in A major " by Chopin will be described relationship between melodic and harmonic structures of music. Each of these structures can be represented as networks, and music - view as multilayer network.

We constructed directed network structure for melody of F.Chopin's "Prelude A-Dur". Figure 1 shows melody network of the piece.

Figure 1. Melody network structure for the Frederic Chopin's prelude A-Dur N7 . The thickness of links corresponds to time of repetitions of appropriate musical intervals



Harmonic structure of a musical work has qualitatively different structure of relations between notes and should be described as a separate layer. We have created a network of harmonic structure of the Frederic Chopin's prelude A-Dur N7 as the second layer. If a piece of music has polyphonic nature, it is easy to describe this musical work as multilayer network too. Multilayer structure of musical works is the consequence of multilayer organization of the human brain networks. It is assumed to briefly discuss the possible mechanism of emotional influence of music from network science standpoint.

Conclusions

Our understanding of complex systems is always associated with incompleteness of information on their structure and properties. A quantitative measure of incompleteness of information on system is its entropy. Recently in the theory of complex networks methods of calculation of entropy both simple monolayer, and multilayer networks on the basis of generalization of the most fundamental concepts and methods of statistical physics are developed [3, 4]. We are developing entropic approach for investigation of music as complex system now.

Acknowledgments

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References and Notes

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