

## EEG based automatic music recommendation system using ranking deep artificial neural network



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**Introduction.** Human preference estimation from electroencephalogram (EEG) has been researched widely in the last decades. Recently, automated information retrieval systems based on machine learning methods have been developed and used widely in online shopping sites, search engines, and so forth.

**Aims.** In this research, we compare artificial deep neural networks for learning to rank, and apply them to a music recommendation system using electroencephalogram (EEG). The learning to rank is a learning method to rank items, such as results of search engines.

**Methods.** The pair-wised learning method is often used to learning to rank. The pair-wised learning is using difference of paired input vectors,  $x_1 - x_2$  as an input, and teaching signal  $\{-1, +1\}$  indicates that which sample should be ranked higher. In order to realize the pair-wised learning in the deep artificial neural network structure, we constructed and compared three different deep artificial neural network structures named RDNN1 to RDNN3. RDNN1 is the most restricted structure, and RDNN3 has higher degree of freedom. We apply the RDNNs to a music recommendation system using EEG. The training and test data are obtained from EEG recorded during listening to music. The target label is obtained from score values evaluated by subjects. In the learning stage, the ranking machine is learned from labeled feature vectors obtained from recorded EEG. In the test stage, the system ranks test data. The RDNNs were initiated by the autoencoder, and re-tuned by the back-propagation algorithm. The python library chainer was used to train RDNNs. The power spectrum density (PSD) and the differential asymmetry (DASM) [1] were obtained from recorded EEG, and used for the ranking. Five healthy males (age: 21–23) were voluntary participated in the experiment. Each subject listened to 100 pieces of music. A piece of music lasts 15 seconds, and after listening to every piece of music, the subject scored the music. From the data obtained by the experiment, data including artifact noise (60V) was removed.

**Results.** The classification accuracy and the normalized discounted cumulative gain (nDCG) [2] were compared. The classification accuracy and the standard deviations for RDNN1–3 were 85.62 ± 8.33, 82.53 ± 12.45, 79.21 ± 7.98, respectively. nDCG for RDNN1–3 were 0.73 ± 0.13, 0.81 ± 0.14, 0.63 ± 0.12 respectively. In the document retrieval systems, averaged nDCG value is around 0.5.

**Conclusion.** We constructed three ranking deep neural network structures, and applied them to EEG based music recommendation system. RDNN2 exhibited the best nDCG performance.

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## FAR NORTH. ADAPTATION DISORDERS. MANAGEMENT AND PREVENTION



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**Introduction.** In the Far North the human body is simultaneously exposed to numerous rapidly changing adverse environmental factors. Adaptation of a person to the conditions of the Arctic continues to be one of the topical problems of polar medicine. The main task in this field is to improve activities aimed at preserving and strengthening health, eliminating the harmful influence of environmental factors, preventing the occurrence and spread of diseases, identifying of early causes and conditions for their development, and developing and implementing healthy lifestyle programs [1].

**Aims.** Improvement of adaptation disorders prevention and optimization of organizational measures in the Far North [2].

**Methods.** In this study, 250 men were examined: 150 people in the study group and 100 people in the control group. All persons were approximately equal by age, height and weight. Medico-statistical methods were used as well as Spielberger's State/Trait Anxiety Inventory, Lusher test, Ruffier functional test, Stange-Hench test, also indices of maximal oxygen consumption, biochemical and hormonal values were assessed [3].

**Results.** Peculiarities of the gut microbiota were revealed in the case of environmental and professional overexertion and adaptation disorders in the Far North, accompanied by a decrease in the level of saprophyte microflora (bifidobacteria, lactobacilli, bacteroides, lactose-positive E. coli), and a significant increase in pathogenic microorganisms (Clostridium, hemolyzing E. coli, Staphylococcus aureus and yeast-like fungi). Programs for correcting the early manifestations of gut microbiota disorders were developed. Measures have been set up to identify groups of neuropsychic resistance, medical and psychological support. The factors of psychophysiological status determining the degree of adaptation disorders were defined. As a result of the calculations, a mathematical model was developed [4].

**Conclusions.** Temporary residence in the Far North is followed by disorders of functional activity of gut microbiota, metabolic disorders and worsening in psychophysiological indices. Here we propose a set of organizational measures for adaptation disorders prevention. It was revealed that the adaptation disorders are caused by the chronic adaptive overexertion syndrome, which results in a high level of the overall morbidity of migrants arriving in the Far North [5].

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