Journal of Artificial Intelligence Practice (2024)
Clausius Scientific Press, Canada

DOI: 10.23977/jaip.2024.070110
ISSN 2371-8412 Vol. 7 Num. 1

Exploration of Deep Learning Evaluation from the Perspective of Multimodal Data Analysis

Haonan Cui

Department of Information and Control Engineering, Shenyang Institute of Science and Technology, Shenyang, Liaoning, 110000, China

Keywords: Multi-modal Data; Analysis; Deep Learning Evaluation

Abstract: Deep learning evaluation is a new direction formed by intersection in multiple fields. By constructing a deep learning database and constructing a deep learning evaluation model, it plays a role in optimizing educational evaluation. Based on the current situation, the main purpose of deep learning evaluation is to follow educational laws, optimize educational reality, and promote educational development. Consequently, various aspects such as data collection automation, deepening education, and enhancing decision-making intelligence should be integrated into deep learning evaluation. Therefore, this article mainly explores the deep learning evaluation under the multi-modal data analysis perspective for reference.

1. Introduction

Under the background of the rapid development of many new technologies such as big data, artificial intelligence and the Internet of things, the educational paradigm has also begun to change. Because the great transformation of the educational paradigm is one of the important contents of education modernization 2035, we should actively adopt the methods of data classification, data and layer and network analysis to collect, sort and analyze the relevant data, so as to promote the realization of the model of educational strategy digitization as soon as possible. In the process of the transformation of education mode, the evaluation of deep learning has been paid more and more attention. Deep learning evaluation is to collect multimodal data on learner's behavior, movement and classroom, and build a database of deep learning factors on this basis, and build a prediction model at the same time, so as to provide more comprehensive, multimodal and comprehensive application services for teachers, learners, educational researchers and relevant managers[1]. According to the current situation, although there are a large number of relevant studies, most of them are in the state of lack of all-round and full cycle multimodal data analysis paradigm. Therefore, it is of great significance to explore the evaluation of deep learning from the perspective of multimodal data analysis.

2. Deep Learning Evaluation System

The design of learning evaluation system is the process of selecting appropriate evaluation methods based on learning objectives and organizing evaluation content. Learning objectives are

both the foundation and important basis of learning evaluation. The determination of learning objectives requires the theoretical basis of educational goal classification theory. The most frequently used and influential goal classification theory in the world is Bloom's Educational Goal Classification Theory, which divides educational goals into three different areas: cognitive, motor skills, and emotional. The classification methods with high application frequency in different areas are Bloom's Cognitive Goal Classification, Simpson's Motor Skill Goal Classification, and Klassow's Emotional Goal Classification. All three are also important theoretical foundations for the design of learning evaluation. Based on this, a learning evaluation system integrating cognitive, motor skills, and emotional aspects can be constructed. However, in practice, traditional forms of learning evaluation have certain limitations. If multimodal data can be applied to it, it can deepen the understanding of learners through their learning habits, psychological dynamics, and thinking habits. It can not only evaluate learners' learning situation, but also pay attention to learners' implicit characteristics such as learning behavior and learning emotions, which can significantly improve the effectiveness and efficiency of deep learning evaluation. At the same time, a deep learning evaluation system integrating knowledge logic, emotional attitude, and other aspects can be constructed[2].

3. Multi-modal Data Analysis from the Perspective of Deep Learning Evaluation.

3.1 The basic process of constructing the database of deep learning.

3.1.1 Data collection

Applying advanced technologies such as big data deep mining, artificial intelligence, deep learning, and blockchain, and combining advanced devices such as microphones, cameras, electroencephalography equipment, and psychological sensors, comprehensively collect various behaviors and corresponding environmental data generated by learners during the learning process, and implement slicing processing for multimodal data. The database can be divided into fields according to disciplines, learning stages, gender, region, etc., reflecting the learning situation and development law of individual or group learners, and providing storage support for extracting features and integrating data for multimodal databases.

3.1.2 Data annotation:

In this study, we commenced by preprocessing the physiological electrical signals to ensure data integrity and prepare the foundation for subsequent analyses. Subsequently, we extracted between 24 to 36 sets of nonlinear features from the preprocessed signals and subjected them to normalization procedures, aiming to mitigate systematic errors and facilitate comparative conditions. To address the inherent complexities of high-dimensional data, dimensionality reduction was performed via Independent Component Analysis (ICA). Moreover, we employed recursive quantization analysis to compute pertinent physiological parameters, intending to uncover potential biomarkers. Lastly, through an integrated analytical approach, we successfully extracted eye movement and electrodermal signals from the acquired data, which are crucial for further understanding of physiological states and behavioral responses.

3.1.3 Data analysis

During the process of data analysis, it is necessary to use deep belief networks to implement decision-making classification for data in five modalities: "brain-behavior- cognition-environment-technology", and build four learning indicators, namely "meta-cognition", "learning

engagement", "learning focus" and "learning emotion". After entering the decision-making stage, deep Boltzmann machines should be used to implement decision-making classification for learning indicators, build a learning factor relationship model, and analyze the cognitive level after deep learning, in order to build a complete and highly reliable multimodal deep learning database[3].

The basic framework of deep learning evaluation.

A comprehensive deep learning evaluation framework can lay an important foundation for the development of deep learning evaluation work. In order to comprehensively monitor and reasonably evaluate the learning process and learning status of learners, the basic framework of deep learning evaluation should mainly include three levels to comprehensively measure the actual quality of deep learning. The three levels are basic course quality, teaching behavior, and interactive feedback.

3.2. The basic quality of the basic course

The basic quality of the basic course puts forward certain requirements for the basic performance of teachers. Teachers should avoid "negative behaviors" in the teaching process. Based on this, the evaluation standard of basic course quality is divided into two different perspectives, namely "teaching demeanor" and "teaching red line". The former mainly includes the teaching environment of teachers, such as whether it is too dark or noisy, while the latter mainly includes the normativity of teachers' behaviors, dresses and languages. The above circumstances can all lead to the psychological state of learners, so it is necessary to monitor them in order to implement the "bottom function" of deep learning evaluation.

3.2.1 The teaching behavior

The teaching behavior system can accurately detect behaviors that are conducive to improving teaching effectiveness. Teaching behaviors mainly include teaching actions and teaching skills. The action level includes giving learners positive incentives, urging learners to complete the learning process, and effectively organizing classroom teaching activities. The skill level mainly includes language, actions, tone, expressions, etc. that are conducive to attracting learners' attention and improving learning effectiveness. Teachers can adjust the use of teaching skills appropriately for different subjects and different learning stages.

3.2.2 Interactive feedback layer

The core of deep learning evaluation lies in learners, but in the teaching process, only if there is full communication between teachers and students, can the learning effect of students be guaranteed. In order to improve the effectiveness of deep learning evaluation, it is necessary to adopt three evaluation indicators: (1) Expression: whether learners and teachers have sufficient interaction in the teaching process can affect the learning effect of learners to a certain extent. Because in the teaching process, learners are the main body, and teachers are the leading factor. If there is insufficient interaction between them, teachers will not understand the actual situation of learners, and cannot give them sufficient guidance, which is not conducive to improving their learning effect. The expression of learners in the learning process can also be divided into different levels. Firstly, we can judge the classroom participation of learners according to the length of their expression content. In general, if students' expression is usually short sentences like "um", "I see", "OK", it means that students may not actually participate in the interaction between teachers and students. If there is dialogue between teachers and students, and the frequency is relatively high, then the teaching effect is significantly better than that of one-way questioning or explaining; (2) Writing: whether students write completely fitted with teaching aims, teaching content, and teaching process during learning process is also an important index to evaluate the deep learning of students.

Currently, it mainly includes two evaluation dimensions: notes and doing exercises. Collection of written data can be achieved by writing on a digital board or taking pictures of writing on ordinary paper with pen or pencil. As for learners' notes content, quantity is not the most important thing, but the form and logic of recording should be observed. In terms of students' doing exercises, it mainly observes the logic and rationality of their thinking process; (3) Summary: that is, learners need to summarize the learning content during the learning process. In addition to setting up a summary link in class, two aspects should be observed: firstly, whether learners can summarize the reasons for errors and solutions when they encounter problems; secondly, whether students can develop mind maps based on their understanding of learning content[4].

The above three evaluation indicators can basically cover all current deep learning processes, and can quantitatively evaluate different aspects of learning process to fully reflect learners' learning status and achieve deep learning evaluation.

3.3 The operational mechanism of deep learning evaluation

The operational mechanism of deep learning evaluation is based on multi-modal data. In this mechanism, on one hand, learners should be regarded as the core. In different scenarios such as life, in-class learning and extracurricular learning, comprehensive data collection should be carried out and the data should be analyzed in real time. On the other hand, interaction among environment, technology and learners should be actively carried out to ensure that the operational mechanism of deep learning evaluation remains in normal operation and has comprehensive evaluation function in the evaluation system to evaluate teaching, research, evaluation and management from multiple perspectives. Based on the above, four key elements can be proposed in the analysis of deep learning evaluation operation mechanism to improve the systematicness and implementability of deep learning evaluation analysis work.

3.3.1 Data collection and prediction

Among the four key elements, data collection and prediction occupy the top priority. Firstly, it is necessary to choose the equipment for data collection and capture reasonably. The equipment should have three characteristics: richness, frontier and adaptability to ensure the comprehensiveness, targetedness and effectiveness of the data collection process, so as to build a scientific and reasonable deep learning database. At the same time, in the process of model operation and detection, a fully automatic and dynamic operation mode should be adopted to improve the effect of cyclic verification, so as to continuously grasp the dynamic performance and index changes of learners, and avoid the phenomenon that the actual situation of learners is too far from the prediction model[5].

3.3.2 Multi-modal data fusion

First of all, various data are obtained through sensors. Then advanced technologies such as deep learning technology and big data technology are used to extract data features and perform corresponding processing to ensure the systematicness, scientificness and accuracy of the analysis model.

3.3.3 Dynamic interactive collaboration

In the overall analysis model, different scenarios, stages and elements need to coordinate and operate together. The situation is complex. In order to achieve the harmonious unity of four aspects: people, technology, data and environment, a multi-subject dynamic interaction mode should be

adopted for collaboration. For example, learners use wearable devices, sensors and other devices to communicate with teachers, classmates, environment and Educational administration system to obtain real-time feedback.

3.3.4 Learning service

In order to highlight key elements in the analysis model of deep learning evaluation, the learning-centered concept should be fully respected when developing models and regulating, running, evaluating and optimizing later stage operations. It is not only necessary to make clear the goals and standards of service, but also to actively improve the optimization level of it so as to ensure that learners' intelligent adaptive ability continues to improve.

4. Multi-modal data analysis perspective key technology of evaluation for deep learning.

4.1 Design and application of a general multimodal data technology framework

In order to ensure the sustainable and healthy development of deep learning evaluation, it is necessary to enhance the usability of the above framework, which requires multimodal audio-visual data flow for the deep learning evaluation process, and the use of artificial intelligence algorithms for accurate detection and real-time analysis. Based on this, a general multimodal data technology framework is designed, as shown in Figure 1. Based on this framework, artificial intelligence algorithm models can be run according to different scenarios and needs, so as to evaluate the deep learning process reasonably. Mobile terminals, handwritten versions, PCs, cameras, etc. are all common terminal devices in the educational scenario, which can comprehensively collect multimodal data related to teacher and learner behavior. After obtaining real-time data, the data should be transferred back to the database for storage.

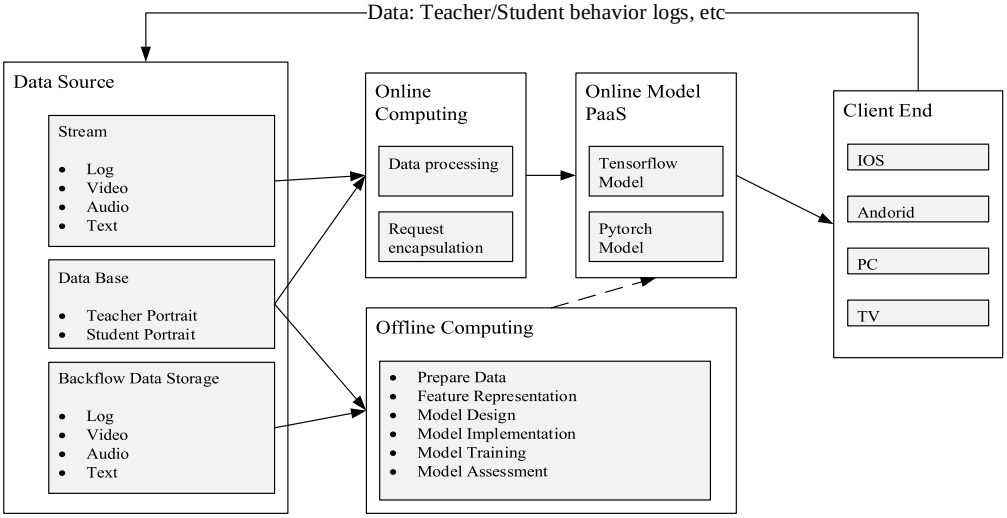

Figure 1: General multimodal data technology framework

The design of algorithm models based on artificial intelligence technology requires intelligent evaluation from different dimensions and levels. In the evaluation process, the dependence on algorithm models related to multimodal data sets varies. Overall, the basic course layer places more emphasis on applying computer vision and intelligent speech technology, while in the teaching behavior and interactive feedback levels, it focuses more on applying natural language understanding technology. Moreover, when performing algorithm analysis, artificial intelligence evaluation feedback process cannot be conducted by human participation, in order to fully achieve

end-to-end evaluation and deep learning.

4.2 Across-temporal multi-modal prediction model

From the perspective of the model, in order to ensure the scientific nature of the modeling process, it is necessary to first clarify the occurrence mechanism of things and gradually solve various problems existing in the process of research and development, feedback, and operation. Therefore, in the process of designing and constructing cross-temporal multimodal prediction models, it is necessary to integrate multiple modes according to actual needs to enhance the scientific nature of the modeling process. For example, in the current environment of integrated education applications, it is necessary to map the relationship between multimodal data and deep learning, gradually forming a systematic and comprehensive prediction model, and finally realizing the construction of a three-dimensional model of human brain, behavior, environment, cognition, technology, etc. in the process of cross-temporal learning, so as to predict and evaluate physiological signals and related behavioral changes generated during deep learning.

5. Conclusions

In the perspective of multimodal data analysis, the key points of deep learning evaluation are collaboration, innovation, and authenticity. In order to more reasonably meet the needs of educational development, it is necessary to first clarify the basic construction process of deep learning databases, propose the basic framework and operating mechanism of deep learning evaluation, and then clarify the key technologies involved. In this way, a deep learning evaluation model under the perspective of multimodal data analysis can be effectively constructed. Moreover, with the development of the times and scientific and technological progress, the level of artificial intelligence technology continues to improve, and educational evaluation reform continues to develop. Deep learning evaluation will surely become an important achievement in the development process of China's education industry.

References

[1] Zhang Kang. Research on feature fusion of multimodal data based on deep learning [D]. Qilu University of technology, 2021
[2] Chen Ran, Zhao Jing. Large scale measurement method of aesthetic cognitive law based on multimodal deep learning [J]. Decoration, 2021 (7): 106-111
[3] Tong Wei. Research and application of large scale examination quality assessment method based on deep learning [D]. Anhui: University of science and technology of China, 2021
[4] Hu hang, Yang min. Evaluation path and strategy of deep learning from the perspective of multimodal data analysis [J]. China Distance Education (Comprehensive Edition), 2022 (2): 13-19
[5] Zhang Tingting, Zhang Xihai, Wang Dongchen. Design of seismic comprehensive data analysis system based on heterogeneous data fusion [J]. Electronic design engineering, 2022, 30 (17): 132-136