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APPLICATION OF ARTIFICIAL INTELLIGENCE AND NEURAL NETWORKS IN EDUCATION

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Abstract: This article examines the trends in the use of artificial intelligence and neural networks in the modern education system. The effectiveness of artificial intelligence algorithms in individualizing learning, adaptive learning platforms, and automating assessment processes is demonstrated. It also highlights existing barriers to technology implementation and issues of digital ethics.

Keywords: Artificial intelligence, neural networks, adaptive learning, individualization, NLP (natural language processing), LMS (learning management system).

"Artificial Intelligence (AI) is one of the most important general-purpose technologies in human history, rapidly transforming all areas of society. In the era of the digital economy and the fourth industrial revolution (Industry 4.0), the education system is moving from traditional methodologies to universal digital ecosystems. Artificial intelligence and artificial neural networks (ANNs) are the main drivers in this process. Neural networks, imitating the principles of the human brain, allow us to analyze large volumes of data and identify complex patterns. Integrating them into education helps create an environment that is tailored to the individual needs of each student.

According to a survey of parents conducted by EdCrunch, the Center for Online Learning and Digital Corporate Training, 72% of children are constantly distracted and study less effectively without teacher supervision. 29% noted interruptions in digital learning platforms as a demotivating factor in learning. Artificial intelligence allows for changes in learning and increases student engagement. By implementing modern technologies, educational platforms and organizations are becoming more attractive to applicants and increasing profits. Learning using neural networks provides a completely different experience for everyone.

The biggest flaw in higher education is the one-size-fits-all approach. The curriculum should be suitable for everyone. Artificial intelligence allows for the creation of a customized program for each student, taking into account a number of unique characteristics. The parameters for choosing a curriculum can include past tests, work experience, interests and social status, previous course results, psychological profiles, and much more. After collecting information about visitors, psychological profiles are created, which are used to develop a recommendation system for course offerings. Continuous training of the neural network increases the accuracy of recommendations and identifies new user requests for the development of the platform.

The most common approach to training neural networks is supervised learning, which uses labeled data to associate a feature with an object description. Supervised models are widely used to predict performance metrics such as real estate prices, student grades, student loan approvals, assignment completion times, and identifying students by photo or camera. Unsupervised learning (using unlabeled data) is used in classification problems to group objects, identify types of defects, types of diseases, psychological types, and learning styles of students.

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Neural networks are highly effective in the learning process mainly in the following three areas:

1) Adaptive learning and individualization

The traditional system uses a "one-size-fits-all" approach. Neural networks analyze the student's:

Speed of mastering the subject;

The nature of the errors they make;

The time spent concentrating.

Based on this data, the algorithm forms an individual learning trajectory for each student. For example, additional visual materials or simpler tasks are loaded on difficult-to-understand topics.

Adaptive Learning Paths with Neural Networks is a personalized learning path that uses artificial intelligence and neural networks to adapt to each learner's individual learning style, learning rate, and level of knowledge. Its principles of operation are as follows:

• Static and dynamic analysis: The system analyzes the learner's static parameters, such as age, gender, background knowledge, and learning style (visual, auditory, kinesthetic), as well as the tasks completed, time spent, and errors in real time.

• Automatic adaptation: Neural networks identify which topics the learner is struggling with and adjust the next course materials, video lessons, or tests accordingly.

• Prediction: Predicts future learning strategies based on the learner's success and acceptance rate.

2) Automate the grading system

The combination of natural language processing (NLP) and neural networks allows you to grade not only test tasks, but also open-ended questions, essays, and creative works. This saves teachers time and reduces the risk of subjective grading (the human factor).

Natural Language Processing (NLP) models are divided into the following types:

• Transformer and LLM models (GPT, BERT): They perform semantic analysis of the student's text responses to essay or open-ended questions. They are used to provide automatic explanations for errors and act as an intelligent tutor (system-advisor).

Transformer and LLM models (GPT, BERT) today form the basis of the field of artificial intelligence and Natural Language Processing (NLP). Transformer is a revolutionary neural network architecture that allows for parallel processing of data, not sequentially, and on its basis, large language models (LLM) such as GPT and BERT were created.

Student Modeling Systems:

• BKM (Bayesian Knowledge Tracing): Determines whether a student has mastered a certain skill or not using Markov chains and probabilistic control. The system updates the student's knowledge level after each answer.

• IRT (Item Response Theory): A mathematical model that correlates the difficulty of test questions with the actual knowledge level of the student. The questions dynamically become harder or easier depending on the student's response.

• DKT (Deep Knowledge Tracing): The use of neural networks (mainly LSTM or RNN) to assess student knowledge. It analyzes the student's entire learning history and predicts with high accuracy whether the student will answer the next question correctly or incorrectly.

3) Predicting student academic performance

Using predictive analytics models, neural networks predict a student's final exam results or risk of dropout based on their current performance at the beginning of the semester. This allows the teacher to systematically work with a low-performing student in a timely manner.

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Today, several platforms based on neural networks are successfully used in global educational practice:

System/ Platform	Applications of neural networks	Achieved result
Knewton/ Carnegie Learning	Adaptive content delivery to give algorithms.	Mathematics and clear sciences mastery indicator up to 30% increased
Duolingo	Natural the language again work and the speech familiar neuron networks .	User to their mistakes adaptable personal language study environment
Generative SI(ChatGPT etc.)	Big language models (LLM).	Students 24/7 for working virtual tutor task to do

The Duolingo platform makes extensive use of Natural Language Processing (NLP) and Speech Recognition neural network technologies to make the language learning process more effective. With the help of these technologies, the application can analyze the spoken and written responses of millions of users in real time.

The main areas of artificial intelligence and neural networks used in the Duolingo system are as follows:

1). Speech Recognition

Special deep neural networks (Deep Neural Networks) are used to check the user's pronunciation.

• Pronunciation analysis: The application records the words you speak and compares them with acoustic models of native speakers.

• Error detection: The neural network determines which phoneme (sound) or word in the sentence is pronounced incorrectly and provides feedback to the user.

2). Natural Language Processing (NLP)

The text exercises and grammar check process are fully based on NLP algorithms.

• Adaptive translation: The user can translate a sentence in several different ways. Duolingo's neural networks understand the meaning (semantics) of the text and accept the correct answers from among the variations.

• Error typology: The system does not simply call the spelling or grammatical errors in the text you write "wrong", but analyzes which rule was violated.

3). Personalization and Birdseye (AI Models)

Duolingo uses a neural network model called "Birdseye" to predict a user's word recall. This model is based on the spaced repetition method, which calculates when you are likely to forget a word and adds that word back to the lessons at the right time.

4. Generative AI and GPT integration

The system has integrated neural networks based on the GPT-4 model from OpenAI in its Duolingo Max plan. This provides the following capabilities:

• "Explain My Answer": When the user makes a mistake, the AI interactively explains why the mistake was made.

• Roleplay: The ability to interact with artificial intelligence in different situations (for example, ordering coffee in a cafe) as if it were a real person.

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Along with the positive aspects, there are also serious problems with the introduction of neural networks into education:

• Digital inequality: Using high-tech SI systems requires powerful servers and stable internet, which is not available in all regions.

• The "Black Box" problem: Neural networks cannot clearly explain how they made a decision (for example, why they gave a particular grade), which reduces transparency.

• Academic integrity: There is a growing tendency to completely transfer tasks that should be completed independently by students to generative intelligence. This weakens the ability to think critically.

Analyzing student behavior and drawing an individual learning path for them in neural network adaptive learning platforms is one of the most complex areas of modern artificial intelligence. This process requires real-time calculation of the learner's knowledge level, mental readiness, dropout tendencies, and speed of learning. After the knowledge level and behavior are determined in the individual trajectory drawing (Path Optimization) system, the learner must choose the next lesson or exercise that best suits him:

• Reinforcement Learning (RL): Here, the adaptive system takes on the role of the "Agent". Q-Learning or Deep Q-Networks (DQN) algorithms recommend content to the learner. If the learner masters the topic well, the system rewards him. The algorithm learns a strategy that maximizes long-term learning efficiency.

• Markov Decision Processes (MDP): Considers the learning process as a set of states (States - the student's current knowledge) and actions (Actions - presenting new material) and calculates the shortest learning path by solving optimality functions.

• Graph Neural Networks (GNN): Used to build inter-disciplinary and inter-subject relationships (Knowledge Graph). For example, the relationship that in order to learn a subject, you first need to know the information related to it is introduced into the neural network.

Artificial intelligence and neural networks cannot completely replace the teacher in the education system, but will become his closest assistant. In order to achieve effective results in the future, it is necessary to introduce a hybrid education model. In this case, the methodology is controlled by a person, and the technical and analytical processes are transferred to neural networks. Also, the formation of a culture of working with SI and digital ethics in students is a requirement of the time.

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