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RECENT TRENDS AND APPLICATIONS OF THE ARTIFICIAL INTELLIGENCE IN THE EDUCATION

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Abstract. In the recent years, the use of artificial intelligence in the education domain has experienced a significant growth. The main reasons for this are the numerous innovative solutions, products and services, which are used not only in the educational processes, but also in the corresponding to them administrative activities. Based on this, the present publication aims to present the latest trends and the applications of the artificial intelligence in the education sector. This research has led to the identification of several key areas, in which the artificial intelligence has a significant contribution to the educational processes, including the adaptive assessment, the intelligent tutoring systems, the educational data mining, the personalized learning, the virtual reality, etc. This publication also presents some of the potential benefits, challenges and ethical considerations, which are associated with the use of the artificial intelligence technologies in the education.

Keywords: artificial intelligence; education; adaptive assessment; intelligent tutoring systems; robotic systems

1. Introduction

The artificial intelligence (AI) and the numerous technologies and solutions that are based on it have a massive potential to revolutionize many of our present-day activities. The educational domain is also no exception to this. In the recent years the integration and the use of the AI technologies in the educational processes is gaining a lot of attention, as it is set to reshape the traditional teaching and learning paradigms (Gocen et al. 2020).

With the capacity to analyse big amounts of data, to personalize the learning experience and to automate the majority of the administrative tasks in the educational institutions, the AI is promising to enhance the learning outcomes and to foster many innovations in the pedagogical activities. The majority of the present-day AI solutions, tools and applications are augmenting the teaching effectiveness, improving the student engagement and facilitating a more personalized learning experience. From the adaptive learning platforms, which are tailoring the learning

processes to the needs of the individual students, to the virtual tutors, which are providing real-time feedback, the AI-powered solutions are transforming the educational landscape (Krstić et al. 2022).

Nevertheless, alongside all benefits, the integration of the AI in the learning and teaching processes raises many questions and presents significant considerations. The issues that are related to the data privacy and the ethical implications from the use of the AI in the educational activities are requiring careful attention, so that this technology can be deployed in a responsible manner. Moreover, there is a huge need for educators and trainers, which are to develop the necessary AI-related skills and to guarantee that all potential risks and challenges from the use of the AI are mitigated (Seo et al. 2021).

2. An overview of the main present-day AI technologies

The Artificial intelligence (AI) enables the machines to learn from experience, adapt to new environments and perform different human tasks (Gocen et al. 2020, Krstić et al. 2022). Most examples of AI-driven solutions and services, from chess-playing computers to self-driving cars, rely on specific technologies, like Machine Learning (ML), Deep Learning (DL), Artificial Neural Networks (ANN), Natural Language Processing (NLP), Computer Vision (CV) and other. Using these technologies, the computers can be trained to processing large amounts of data (Big Data) and to recognize patterns in the processed data (pattern recognition) and with this to perform specific tasks. In this way, the present-day AI systems are able to make specific decisions based on the input data, to classify the presented problems and to look for the best possible solutions for them, to plan and find different ways to solve the input problems, to think abstractly and to simulate the processes of solving specific tasks, as well as to represent the data, tasks, activities or knowledge (Akinwalere et al. 2022).

The most widely used AI technologies nowadays are:

– Machine learning (ML) – a method for data analysis that automates the building of analytical models. It is a specific subsection of the Artificial Intelligence and is based on the idea that systems can learn from data, identify patterns and make decisions with minimal human intervention. While AI is the broad science of imitating human abilities, Machine Learning is a specific subsection within AI that teaches a machine how to learn (Kamalov et al. 2023, Dimitriadou & Lanitis 2023).

– Deep Learning (DL) – a type of Machine Learning that trains the computers to perform human tasks, such as speech recognition, image identification or making predictions. Instead of organizing the data to run through predefined equations, DL sets basic parameters for the data and trains the computer to learn on its own by recognizing patterns using one or multiple processing layers (Krstić et al. 2022).

– Artificial Neural Networks (ANN) – algorithms that are inspired by the functioning of the brain and are designed to analyze complex patterns and predict

outcomes. They have emerged from the idea of mimicking the biological neural networks in the human brain. While not exact replicas, the ANNs are closely resembling the biological neural networks in operation. These algorithms primarily process numeric and structured data. For handling unstructured and non-numeric data, like images, text and speech, specialized models like the Convolutional Neural Networks (CNN) and the Recursive Neural Networks (RNN) are employed (Kamalov et al. 2023, Akinwalere et al. 2022, Dimitriadou et al. 2023).

– Natural Language Processing (NLP) – a subsection of the Artificial Intelligence that helps computers understand, interpret and manipulate the different human languages. NLP helps computers communicate with humans in their own language and enables computers to read text, hear speech, interpret it, determine the mood and focus on the important bits of information (Akinwalere et al. 2022; Dimitriadou et al. 2023).

– Computer Vision (CV) – a branch of the AI technologies that trains computers to interpret and understand the visual world. Using digital images from cameras, videos and deep learning models, machines can accurately identify and classify objects and then react to what they "see". From facial recognition to real-time video processing, computer vision can match and even surpass the human vision in some cases (Krstić et al. 2022; Kamalov et al. 2023).

3. Applications of the AI technologies in the education domain

Artificial Intelligence (AI) is having a transformative impact on the education domain, offering innovative solutions to enhance teaching and learning processes. Some of the key areas where AI is utilized for educational purposes are:

– Personalized Learning – the AI systems can analyse the learning patterns of the students and their preferences and can then tailor the educational content and the study activities according to their individual needs. This approach fosters better engagement and comprehension, as the presented materials are corresponding to the learning styles and the needs of the students or the trainees (Gocen & Aydemir 2020; Krstić et al. 2022; Seo et al. 2021; Kamalov et al. 2023; Akinwalere et al. 2022).

– Adaptive Learning Platforms – the AI-powered adaptive learning platforms can dynamically adjust the difficulty level and the content based on the progress and the performance of the trainees. This personalized approach ensures that the students are receiving appropriate support and can maximize their learning outcomes (Kamalov et al. 2023, Dimitriadou & Lanitis 2023).

– Intelligent Tutoring Systems – the AI-driven tutoring systems can provide the students with real-time feedback, guidance and assistance and can simulate the experience of a human tutored training. These systems can adapt the teaching strategies based on the responses of the students and can offer them better support or interactive assistance (Dimitriadou & Lanitis 2023).

– Automating Administrative Tasks – the AI systems can streamline the administrative tasks, like grading, scheduling and resource allocation, freeing up the time of the teachers, so that they can focus on the more meaningful aspects of the teaching (Krstić et al. 2022).

– Smart Content Creation – the AI tools can assist the educators in the development of high-quality content by automating many tasks, like content curation, generation and recommendation. These tools can analyse big amounts of educational materials and can select and customize the contents to suit the specific learning objectives (Seo et al. 2021).

– Predictive Analytics for Student Success – AI algorithms can analyse various data points, including academic performance, attendance and behaviour, to identify the students who might be at risk of falling behind or dropping out. By predicting the potential challenges, the educators can intervene early and provide support (Dimitriadou & Lanitis 2023).

– Virtual Classrooms and Remote Learning – AI-powered virtual classrooms and online learning platforms offer immersive learning experiences and are enabling the students to engage with interactive content, simulations and virtual tutors. These platforms are also known as means to facilitate flexible and accessible education (Akinwalere et al. 2022).

– Enhancing Accessibility – the AI technologies, such as the speech recognition, text-to-speech and image recognition, can enhance the accessibility for students with disabilities. These tools can enable alternative forms of interaction with the educational materials, ensuring that all students can participate in the learning activities (Dimitriadou & Lanitis 2023).

Overall, the integration of the AI technologies in the education holds immense potential to improve the learning outcomes, increase the efficiency and promote inclusivity. Nevertheless, it is crucial to address the ethical considerations, the privacy concerns and the need for responsible AI implementation in the educational institutions.

4. Utilization of the AI technologies and the robotic systems in the educational activities of the schools and the universities

Unlike the AI technologies, which are developed with the idea to replicate the analytical processes and the decision-making activities of the humans, the robotic systems are programmed only to perform specific actions without any analytical functions or human-like consciousness. Nevertheless, these two independent technologies can be used jointly in the educational domain to provide interactive and immersive teaching and training activities. For example, teachers at the University of Ruse use various AI-enabled robotic systems (Fig. 1) to develop, test and demonstrate algorithms for target tracking, autonomous navigation using signs or QR codes or solve simultaneous localization and mapping (SLAM) problems in

unknown environments (DJI. (n.d.). RoboMaster S1, 2024, RYZE Robotics. (n.d.). Tello. RYZE Robotics, 2024, Husarion. (n.d.). ROSbot manuals. Husarion, 2024).

Further to these commercial solutions, the students can also be involved in the development of their own AI-powered robotic solutions, like the AgRUbot precision agriculture robot (Fig. 2), which was developed by the students from the University of Ruse. This robotic system prototype is capable of autonomous navigation in rural areas and is utilizing a CV-based AI algorithm for detection and spraying of weeds.

Figure 1. Different AI-enabled educational robots - the DJI Robomaster S1 robot (left), the DJI Tello Edu drone (middle) and the ROSbot 2 (right), which can can be used correspondingly for development, testing and demonstration of algorithms for target tracking, autonomous visual navigation and simultaneous localization and mapping

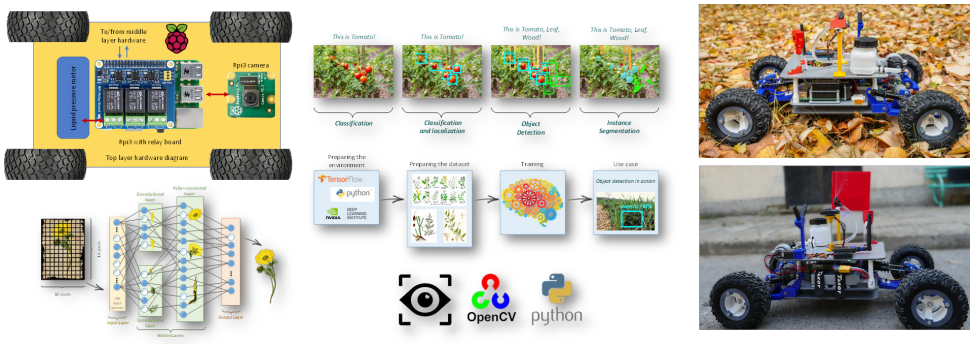

Figure 2. The AgRUbot robotic prototype – a small-scale solution for precision agriculture that utilizes a CV-based AI algorithm for weed detection and spraying

5. Conclusion

The artificial intelligence can be used as a tool to improve the learning processes and can be beneficial for both the learners and the teachers. Some of the key

technologies that ensure the wider spread and use of the AI in the educational activities are the neural networks, the machine and deep learning algorithms, the robotic systems, the augmented and virtual reality platforms, etc.

The AI-driven solutions, tools and applications are rapidly transforming the education domain and are presenting a new set of challenges, which have to be addressed, so that this technology can be used in a responsible and reliable manner. Due to this, the potential benefits, challenges and ethical considerations, which are associated with the use of the AI-technologies in the learning and teaching processes, will remain a popular research topic and will be subject to future surveys and studies.

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