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Editors:

Vesna Spasojević Brkić
Mirjana Misita
Uglješa Bugarić

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Vesna Spasojević Brkić
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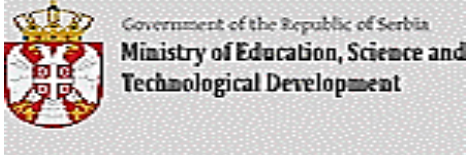

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CURRICULUM TO TEACH ARTIFICIAL INTELLIGENCE FOR VET SCHOOL – DESIGNING AND CHALLENGES

Milica Gerasimovic, Ph.D. /Advisor - Coordinator [1]
Ugljesa Bugaric, Professor[2]
[1]Institute for Improvement of Education, Belgrade Serbia
milica.gerasimovic@zuov.gov.rs
[2]University of Belgrade - Faculty of Mechanical Engineering, Serbia
ubugaric@mas.bg.ac.rs

Abstract. *Artificial intelligence (AI) has become a common ingredient in everyday products and activities and a part of all levels of education. Artificial intelligence is present as a separate subject in schools or as part of the different curriculum in the form of learning outcomes and content. This paper summarizes the design of the artificial intelligence curriculum structure for vocational schools in Serbia and possible challenges in the implementation process. Also, the paper proposes ways of popularizing and providing help to teachers as a response to possible challenges in the teaching of artificial intelligence topics. The paper is created to support the achievement of the goals of the Strategy for the Development of Artificial Intelligence in the Republic of Serbia for period 2020–2025.*

Keywords: *Artificial Intelligence, Education, Curriculum Design*

1. INTRODUCTION

There is no universally accepted definition of artificial intelligence (AI). The widely accepted one was offered by the independent expert group of the European Commission in the report on the definition of artificial intelligence 4 and it reads: "Artificial intelligence (AI) refers to systems that exhibit reasonable, intelligent, behavior based on analysis of their environment and make decisions - with a certain degree of autonomy - to achieve specific goals. AI-based systems can be purely software-based and operate in a virtual world (for example, a virtual assistants, photo analysis software, Internet browsers, speech and face recognition systems) or can be embedded in devices - hardware (for example, advanced robots, autonomous vehicles, drones and the like)" [1].

The first forms of artificial intelligence appeared in the middle of the last century in systems based on logic. Further development of artificial intelligence implies the application of expert systems based on knowledge and later on data. By applying various possibilities of computer processing on huge amounts of data, machine learning is being promoted as a form of artificial intelligence that enables the prediction of future behaviors based on large data sets of previous behaviors.

Today, artificial intelligence is a breakthrough technology that is quickly transforming our society, economy and jobs. Some popular examples of AI applications are social networks, driverless cars, chat bots, voice assistants, internet search engines, robot stock traders, etc. These systems can be embedded in physical machines or be stand-alone software agents acting in the digital space.

Studies indicate that artificial intelligence could in the future period double the annual rates of global economic growth by improving labor productivity due to innovative technologies that will allow the same number of workers to do more, by creating "smart machines" in the form of systems and programs that will be able to learn and solve problems almost independently.

2. EDUCATION BASED ON THE NEEDS OF MODERN SOCIETY AND ECONOMY AND ARTIFICIAL INTELLIGENCE

The modern era implies the use of computers and computer programs in the everyday life of young people. A large variety of artificial intelligence capabilities, such as facial recognition and speech recognition are widely accessible through smartphones, and websites. The widespread knowledge and application of scientific reasoning is a key social aspect in technologically advanced societies. Therefore, it is of great importance that

students find its elements in their curricula as early as possible.

In the past few years, with reforms in the education system, the Republic of Serbia has become one of the leaders in Europe in the education of students in the field of information technology. Informatics is a compulsory subject in primary schools from the fifth grade, where students also learn block programming (most often the Scratch programming language), while from in the sixth grade they also learn text programming (most often in the Python programming language), so that in the eighth grade they already encounter elements of data science.

In vocational education (VET) artificial intelligence topics are represented in the study programs, but what should be learned is not standardized. Learning outcomes and contents related to artificial intelligence are present in the plans and programs of teaching and learning in certain educated profiles in the field of mechanical engineering and electrical engineering. An example is two occupations Industrial Robotics Technician and Machine Technician for Computer Controlled (CNC) Machines, which are qualified to apply artificial intelligence in future work or for further learning about artificial intelligence in future education.

Despite the significant progress related to the learning of information technologies in primary and secondary schools, both in general education and in professional subjects, artificial intelligence topics are still not significantly represented. The Artificial Intelligence Development Strategy of the Republic of Serbia sets a special goal related to the development of education aimed at the needs of modern society and economy conditioned by the progress of artificial intelligence [2].

Education should also respond to broader changes in society and the economy that are a consequence of the progress of artificial intelligence in the world. Despite the fact that it is not possible to predict what it will be like to be the future labor market at the level of individual jobs, there are some trends that can be managed:

- connecting knowledge and skills from social humanistic and artistic field with knowledge and skills from natural mathematical and technical-technological fields;
- increasingly significant and expanding role of data in the area of decision-making.

One of the measures implemented by the Institute for the Improvement of Education in order to achieve the goals of the Strategy is designing curriculum to teach artificial intelligence for VET School.

3. CURRICULUM AND CHALLENGES

The artificial intelligence program belongs to the group of optional vocational programs that will be offered to students of secondary vocational schools in the fields of mechanical engineering, electrical engineering and traffic. Program will be implemented in the third VET school class through 70 hours of exercises. The structure of the program consists of three main parts:

- learning objectives;
- topics, outcomes, recommended content and key content terms;
- instructions for didactic-methodical implementation of the program and assessment.

Learning objectives of artificial intelligence VET school program are:

- getting to know the basics of artificial intelligence and machine learning;
- training for the application of artificial intelligence through an interactive method, case studies and project teaching;
- developing skills such as problem solving and debugging techniques, critical thinking, logical reasoning and creativity.

The rest of the curriculum consists of four main modules:

1. Introduction to artificial intelligence
2. Machine learning and working with data
3. Artificial neural networks
4. Generation of artificial intelligence models.

In each module, the learning outcomes that the student should achieve after completing the course are listed, as well as the topics that lead to the achievement of the prescribed outcomes (Table 1.).

A very important part of the curriculum that is intended for teachers are instructions for didactic-methodical implementation of the program and assessment. Teachers are advised to discuss with students the concept, importance and possibilities of applying artificial intelligence techniques in different fields in the first lessons in the beginning of the course. The instruction to the teachers is to present to the students typical examples of systems based on the application of artificial intelligence techniques, such as ELIZA (a program used for natural language processing), Deep Blue (the first expert system implemented on an IBM supercomputer that won the world chess champion Garry Kasparov), DARPA Grand Challenge (competition initiated to encourage the development of technologies needed to create fully autonomous vehicles), Deep Mind's Alpha Go (Google's Alphago program based on deep reinforcement learning defeated the European and then the world champion, professional of go player Li Sedol – a grandmaster in the ancient Chinese game of go). It is recommended that during the implementation of the program, students get involved in several projects such as: *Understanding the operation of face recognition systems* (testing already developed software solutions such as facenet, deepface, face_recognition or OpenCV) or *Understanding the functionality of text recognition systems* (preparation of data for training, testing and validation of the model). Teachers are advised to look at disciplines important for the development of artificial intelligence, to motivate students to actively participate and analyze examples of the use of artificial intelligence in everyday life.

Table 1. Modules, topics and outcomes

Introduction to artificial intelligence	Machine learning and working with data	Artificial neural networks	Generation of artificial intelligence models
● explain the concept of artificial intelligence ● identifies the key events that influenced the development of artificial intelligence ● explain the role of machine learning in the field of artificial intelligence ● illustrates the possibilities of applying artificial intelligence with examples from everyday life	● describe the basic approaches and abstract models of machine learning ● distinguishes types and basic problems of machine learning ● names software tools and applications that can be used for machine learning ● describe basic techniques for researching datasets relevant to machine learning ● describe basic techniques for collecting and classifying data sets ● state and explain the working principle of basic machine learning algorithms ● explain the importance of using and visualizing the results of machine learning ● explain the application of machine learning on the example of a case study of recommendation systems	● explain the concept of adaptive information processing of intelligent systems using the example of artificial neural networks ● describe the way artificial neural networks work ● list the basic properties and types of architectures of artificial neural networks ● illustrates the application of artificial neural networks on the example of an educational mobile robot - e.g. LEGO robots ● applies artificial neural networks in the process of functional approximation - generalization, classification and prediction using sets of representative samples of relevant data for machine learning	● recognizes a problem from everyday life in the domain of decision-making and connects the possibility of solving it with the application of appropriate artificial intelligence techniques, primarily artificial neural networks ● collects representative samples of relevant data needed for building the model ● prepares relevant data and generates a model ● tests relevant data and interprets machine learning results ● evaluate the quality of the built machine learning model ● uses an artificial intelligence system for facial recognition ● uses an artificial intelligence system for speech recognition ● uses an artificial intelligence system for text recognition

Special attention should be paid to multidisciplinarity in all areas, the development of a multidisciplinary approach, the connection of related disciplines with the parent discipline with the application of elements of artificial intelligence [3].

The development of teacher competencies is a central issue and the main challenge in the implementation of artificial intelligence programs [4]. In order to prepare an adequate training program for teachers on how to teach students about artificial intelligence, research is being conducted to determine the readiness of teachers to implement courses in the field of artificial intelligence. Some of the main claims of the developed questionnaire are: I am familiar with the term artificial intelligence; I am ready for additional training in the field of teaching artificial intelligence; The contents of the courses I teach can be linked to outcomes related to artificial intelligence; Students should develop knowledge and skills related to artificial intelligence. The results of the research will be the basic guidelines in the development of training and support programs for teachers.

Also, in the coming period, it is planned to hold several forums with the aim of introducing teachers to the importance of improving teaching content in primary and secondary schools in accordance with the needs conditioned by the progress of the application of artificial intelligence in modern society.

4. CONCLUSION

In this paper is presented artificial intelligence curriculum for VET schools. This is a one year course based on learning objectives and learning outcomes. The structure of the curriculum consists of four modules, and an important part is the instructions for the didactic-methodical implementation of the program and assessment.

The need to create such a curriculum arose from the fact that modern education, especially VET education, is directed towards the needs of modern society and economy, which are conditioned by the progress of artificial intelligence. The very reason for creating this material at this time is the publication of the Artificial Intelligence Development Strategy of the Republic of Serbia which sets a special goal related to the development of education aimed at the needs of modern society and economy conditioned by the progress of artificial intelligence.

The main challenge in the implementation of the artificial intelligence program in VET schools is the competence of teachers and their readiness for additional training in the field of teaching artificial intelligence. Overcoming this challenge is possible through the permanent popularization of artificial intelligence in education at forums and professional meetings, as well as by providing support to teachers by organizing professional trainings.

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