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ВНЕДРЕНИЕ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В STEM-ОБРАЗОВАНИЕ

В статье описывается подход к внедрению искусственного интеллекта через STEM-образование в болгарской школе. Внедрение осуществляется путем подготовки учителей естественных наук, математики и информатики для последующего обучения учащихся в STEM-центрах школы. Авторы описывают структуру и содержание учебного материала. В статье представлены первые результаты реализации данной программы. Определены направления, идеи и подходы по внедрению искусственного интеллекта и логического программирования через обучение в центрах STEM. Одна из целей — создать сеть центров STEM, предлагающих обучение искусственному интеллекту.

Ключевые слова: *образование, искусственный интеллект, логическое программирование, STEM.*

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INTRODUCING ARTIFICIAL INTELLIGENCE IN STEM EDUCATION

The article describes an approach to introduce artificial intelligence through STEM education in the Bulgarian school. The introduction is carried out through the training of science, mathematics and informatics teachers for the subsequent training of students in the school's STEM centers. The authors describe the structure and content of the study material. The article presents the first results of the implementation of this program. Guidelines, ideas and approaches for introducing artificial intelligence and logic programming through training in STEM centers are defined. One of the goals is to create a network of STEM centers offering training in artificial intelligence.

Keywords: *education, artificial intelligence, logic programming, STEM.*

Created in the 1970s, Prolog has its roots in mathematical logic. Using it to model logic problems is natural, but beyond logic, we suggest the use and study of Prolog for most subjects studied in secondary school. We argue that using Prolog is beneficial in that it requires proper modelling of a problem, which is essential for developing problem-solving skills, as it is often the key to finding a solution. At the same time, students discover a new programming language that is easier to learn than imperative languages because the syntax is close to natural language and the language specification is more synthetic than traditional imperative languages. Solving a problem in Prolog means describing it, and no matter how you describe the problem, no matter how varied the description, Prolog will always return an answer. 2022 marks the 50th anniversary of the creation of the logic programming language Prolog. In connection with our publications related to implementing the study of artificial intelligence (AI) and logic programming in the Prolog language in the middle school, we were

invited to participate in the forum "2022: The Year of Prolog". The Year of Prolog highlights the continued importance of Prolog and logic programming both for symbolic, explainable artificial intelligence AI and for computing in general. Our team supports the implementation of the study of AI and logic programming in Prolog and through the "Digital Bulgaria in Prolog" project. In it, we set out to create knowledge bases in the Prolog language for various areas of our cultural and historical heritage, such as: folklore, historical and natural sights, etc. Our team is also working on the project "MODELING KNOWLEDGE IN THE FIELD OF BULGARIAN FOLKLORE", at the Scientific Research Fund. Rather, it offers a form for structuring and modelling specialized knowledge from the field of Bulgarian folklore. The activities in this project are related to work with STEM canters at secondary schools in Bulgaria, and the project team will introduce students to logical programming and AI and the results obtained. Within the framework of the project, its approbation is foreseen in the STEM (Science, Technology, Engineering, Math) canters of the partner schools. A shared research environment will be established to continue interdisciplinary collaboration.

STEM (Science, Technology, Engineering, Math). In 2023, our team was invited by the management of Professional High School of Electrical and Electronic Engineering - Plovdiv (PHSEEE) to participate in the development of a program for STEM training. A program was developed with which the school applied for the National Program "Innovations in action". The program supports schools with innovative practices. Such a school is the PHSEEE, which together with us developed methodologies for integrative educational content and teaching in STEM. The proposed study in STEM is for a two-year course of study, in the first year the curriculum is on the topic "Artificial Intelligence - Prolog Logical Programming" and in the second year on the topic "Artificial Intelligence - project development process using the Prolog language". The curriculum on "Artificial Intelligence - Prolog Logical Programming" (Table 1) is intended for the education of VIII grade students in PHSEEE, city of Plovdiv. The AI program envisages the mastery of in-depth theoretical knowledge in the field of intelligent systems and the acquisition of a variety of practical skills related to applications of AI methods and techniques in a wide range of areas of informatics and information technology. The program includes theoretical foundations of classical artificial intelligence, knowledge modelling and knowledge base design, information retrieval, knowledge processing, semantic technologies, advisory systems, etc.

Table 1

Curriculum Structure "Artificial Intelligence - Prolog Logic Programming"

№	Name of sections	Minimum number of theory hours	Minimum number of hours of practice
1.	Introduction to Artificial Intelligence	2	
2.	Knowledge	2	
3.	Logic	2	
4.	Logic programming language Prolog	12	16
	Total minimum number of hours	18	16

The curriculum on "Artificial Intelligence - project development process using the Prolog language" (Table 2) is intended for the training of IX grade students in PHSEEE, city of Plovdiv. The program on "Artificial Intelligence - project development process using the Prolog language" provides for the mastery of in-depth theoretical knowledge in the field of intelligent systems and the assimilation of various practical skills related to the development of a software project, applications of methods and techniques of artificial intelligence. The

training in the second year (grade IX) will introduce students to an introduction to software engineering. Students are presented with a fully developed project, which is developed in stages, going through all phases of software development. Students are assigned assignments for group projects in STEM subjects (physics, chemistry, ...). Given the inclusion of this STEM subject in the school's curriculum for the 2023-2024 school year, it was necessary to train teachers from PHSEEE. The teachers were introduced to the curriculum and were trained on it. After the qualification of the teachers, in order to evaluate their knowledge and skills, it was necessary to prepare projects implemented in the Prolog language. In this way, they acquire the competence to prepare their project assignments for the students and support their implementation. After a discussion on choosing a topic, the group of teachers focused on a topic related to the extraordinary wealth of hot mineral springs in Bulgaria, scattered throughout the country. The topic is very well thought out, as it covers all the subjects taught by the teachers involved in the training (chemistry, physics, biology, mathematics, informatics). It is evident from the curricula that project-based learning is at stake.

Table 2

Curriculum Structure "Artificial Intelligence - Project Development Process Using the Prolog Language"

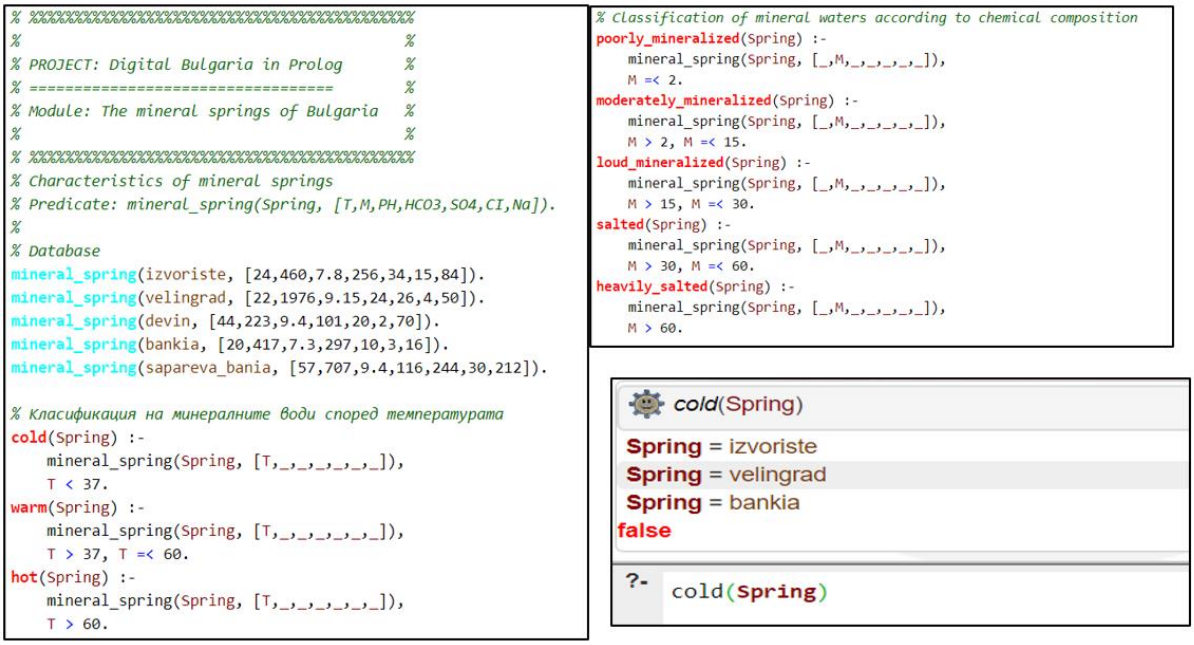
№	Name of sections	Minimum number of theory hours	Minimum number of hours of practice
1.	Software development process.	8	0
2.	Development and defense of an assigned project in STEM (physics, chemistry, ...)	0	24
	Total minimum number of hours	8	24

Example STEM. Bulgaria has an extraordinary wealth of hot mineral springs scattered throughout the country. Along with its balneological and healing properties, Bulgarian waters are extremely interesting in composition and preferred because of their drinking qualities. According to their physico-chemical characteristics, practically all the waters known in nature are present in Bulgaria. It is important to note that mineral water in Bulgaria is not just a tourist attraction, but also part of the national wealth and cultural heritage. To develop a mineral water project using the Prolog language, teachers go through the software development process. In this way, they prepare for presentation to the students a fully developed project, going through all phases of software development. ANALYSIS - At this stage, teachers study literature on the topic and identify objects, relationships and characteristics. Chemistry, physics and biology teachers are actively involved here. Information is collected, processed and classified about the different types of mineral waters, their properties, medicinal benefits, characteristics of the waters, classifications, the types are determined according to the method of extraction, chemical composition and properties of the water. DESIGN - Describes the objects and the relationships between them. What characteristics does an object have? Classification and levels of investment are being prepared. The type of inference engine is determined. DEVELOPMENT AND TESTING - At this stage, the description of rules and facts of the Prolog language begins. The knowledge base for the specific field is being built. The objects in the knowledge base, the relations and the characteristics of the different types of water are described. All teachers in the group actively participate. An example described with rules and facts in the Prolog language was developed (Fig. 1). Facts are described in the knowledge base as follows:

```
mineral_spring(Spring, [T,M,PH,HCO3,SO4,Cl,Na]).
```

where the first argument of the predicate **mineral_spring** is the variable Spring, taking as value the source name (location) and the second argument is a list of water characteristics.

The list is of seven items. The first takes values for water temperature, the second - minerals, the third - pH, etc.



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