УДК 373.1
Венета В. Табакова-Комсалова[1], Станимир Н. Стоянов[2], Таня М. Сребрева[3]
[1] v.komsalova@uni-plovdiv.bg; [2] stani@uni-plovdiv.bg
[1,2,3] Пловдивский университет им. Паисия Хилендарского, Пловдив, Болгария

УЛУЧШЕНИЕ СРЕДНЕГО ОБРАЗОВАНИЯ С ПОМОЩЬЮ ИИ: МОДЕЛИРОВАНИЕ СЕТИ ЛОГИЧЕСКОГО ПРОГРАММИРОВАНИЯ В БОЛГАРИИ

Искусственный интеллект открывает новые возможности в образовании. Логические и основанные на знаниях подходы к разработке программного обеспечения для искусственного интеллекта включают представление знаний, логическое программирование, базы знаний, механизмы вывода и дедукции, суждения и экспертные системы. В статье рассматриваются концепция, методология и построение виртуальной сети для обучения логическому программированию в болгарских средних школах. С помощью этой сети мы стремимся сделать учеников не только пользователями, но и создателями систем искусственного интеллекта.

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

Исследование выполнено при финансовой поддержке научному проекту КП-06-М62/2 „МОДЕЛИРОВАНИЕ ЗНАНИЙ В ОБЛАСТИ БОЛГАРСКОГО ФОЛЬКЛОРА“, финансируемому Фондом „Научные исследования“.

Veneta V. Tabakova-Komsalova[1], Stanimir N. Stoyanov[2], Tanya Srebreva[3]
[1] v.komsalova@uni-plovdiv.bg; [2] stani@uni-plovdiv.bg
[1,2]Plovdiv University ‘Paisii Hilendarski’, Plovdiv, Bulgaria

ENHANCING SECONDARY EDUCATION WITH AI: MODELING A LOGIC PROGRAMMING NETWORK IN BULGARIA

Artificial intelligence opens up new opportunities in education. Logical and knowledge-based approaches to artificial intelligence software development include knowledge representation, logic programming, knowledge bases, inference and deduction engines, judgments, and expert systems. The article examines the concept, methodology, and construction of a virtual network for teaching logic programming in Bulgarian secondary schools. Through this network, we aim to make students not only users but also creators of AI systems.

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

Artificial intelligence (AI) is revolutionizing education, offering new opportunities to improve teaching and learning. In Bulgaria, as in many other countries, the integration of AI in secondary education is very promising. A notable initiative in this direction is the development of a logic programming network intended for secondary schools in Bulgaria. This initiative not only introduces students to advanced AI concepts but also fosters fundamental skills such as critical thinking, problem solving, and teamwork. This article explores the potential benefits of AI in Bulgarian secondary schools, focusing on the development of a logic programming network. AI can bridge gaps in education by providing personalized learning experiences, adapting to individual student needs, and ensuring equal access to quality education. Through interactive and hands-on learning approaches, AI helps students develop essential 21st-century skills. AI-powered tools analyse student data, identifying patterns and areas for improvement. AI-powered systems can provide access to a wide range of educational resources and tools, enhancing the learning experience. Educators can use this information to personalize instruction and support. Algorithms learn from data, enabling predictive analysis, early intervention, and personalized feedback. AI algorithms can

create personalized learning paths for students based on their strengths, weaknesses, and learning preferences. Adaptive learning platforms adjust content difficulty, speed, and grades to optimize student progress. AI-guided tutors provide real-time feedback, answer questions, and guide students through exercises. These systems adapt to individual learning styles and paces. AI automates grading, reduces teacher workload, and ensures consistency. It can also identify plagiarism and evaluate student performance more objectively.

A logic programming network combines AI techniques with logical reasoning. In Bulgaria, such a network could increase the problem-solving skills, critical thinking, and creativity of secondary school students. Students can participate in programming challenges, puzzles, and simulations, encouraging computational thinking.

The virtual network developed in Bulgaria is an innovative model that supports the teaching of logic programming in secondary schools. This network is built as a distributed knowledge base with a modular architecture. Here's a closer look at its key features:

- Distributed knowledge base. The network functions as a distributed knowledge base, allowing seamless integration of new modules created by individual developers. This modularity ensures that the network can grow and adapt to include new educational content and tools.
- Shared User Access: The network is designed to provide shared user access, encouraging collaboration and resource sharing between students and faculty.

Approaches to managing distributed knowledge bases. The management of distributed knowledge bases in the network uses two main approaches:

- Logic programming language: Using a logic programming language to manage the knowledge base ensures a structured and systematic approach to problem solving and knowledge representation.
- Combination with Imperative Programming: The integration of logic programming with an imperative programming language allows greater flexibility and functionality, enabling the development of more complex educational tools and applications.

The effectiveness of the network is demonstrated through practical applications developed by students from different schools in Bulgaria. These examples highlight how the web can be used to create educational content in a variety of subjects, including biology, chemistry, and physics. By participating in the logic programming of educational programs and knowledge bases, students not only improve their understanding of the subject matter but also develop critical skills such as: initiative, risk assessment, creativity, critical thinking, teamwork, responsibility.

Virtual network concept, model, and architecture. The virtual network in question is a distributed knowledge base structured modularly. This architecture allows individual developers (students and school teams) to create and integrate their own modules seamlessly into the wider network infrastructure. Such a modular approach provides flexibility and scalability, catering to the diverse needs of teachers and students in different schools. Shared user access is a key feature promoting collaboration and resource sharing among participants. The virtual network architecture (Fig. 1) is composed of two parts: the client and the server.

Demonstration of network usability by schools and students. The practical usability of the network is illustrated by two examples developed by students of different age groups in different Bulgarian schools. These examples show how students can use the web to create meaningful projects that span multiple educational subjects such as biology, chemistry, physics, and more. [1]. By engaging in logic programming and developing knowledge bases, students can understand complex scientific concepts more intuitively. The examples presented, developed by students from different age groups and schools in Bulgaria, are in the "Biology" module, where students create a logic-based module, a model classification of animals, and a classification of plants.

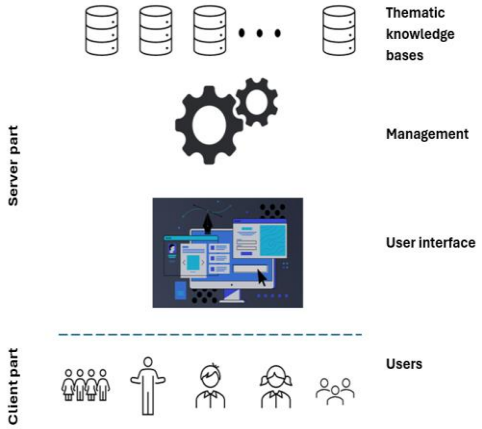


Fig. 1. Virtual network architecture

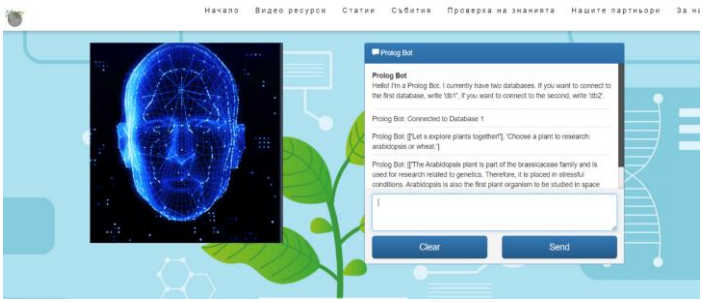


Fig. 2. Web application interface

Example 1. At "Alexander Georgiev-Kodjakafaliyata" Elementary School, Burgas City, training in logic programming in the Prolog language was introduced. The training is organized in groups for activities according to interests, aimed at students in the IV and V grades. The information technology and informatics teacher work with this group together with a science teacher. They introduced a program to create intelligent assistants using the Prolog programming language. Teachers have prepared a variety of Man and Nature curriculum topics for students to work on.

The main stages students go through in creating these intelligent assistants are:

- *collecting the necessary literature*. Initially, students are introduced to the basic concepts of logic programming and the features of the Prolog language. The study includes both theoretical material and examples of practical applications. Students learn to recognize different types of data and create simple facts and rules.
- *system design.* After mastering the basics, students move on to designing their own smart assistants. They define the goals of the system and draw up a plan for its implementation. In this stage, students create a knowledge base of facts describing different types of pine trees, for example:

```
pine (white_pine, needles_2_bundles, length_5_8_cm, thin_cracked_bark, seeds_with_wing_15_mm).
pine (blackberry, needles_2_bundles, length_3_6_cm, heavily_cracked_bark, seeds_without_wing).
pine(common_fir, needles_flat, length_1_5_2_5_cm, smooth_bark, upright_cones).
```

Students also define rules that allow the system to ask questions and receive answers:

```
write('Choose one of the columns and answer the following questions about it: white pine, black mulberry, common fir, black pine, white mulberry.'), nl,
```

- *development and testing*. After the design, the students proceed to the actual development of the system. They implement their ideas in Prolog and test the system for bugs and inaccuracies. In the testing process, students learn how to detect and fix problems and optimize the performance of their smart assistant.

The thematic database thus constructed, supplemented with governing predicates, is added to the virtual network. Through this project, students not only learn the basics of logic programming in the Prolog language but also develop their logical and analytical skills. Working in a team and solving real-world problems motivates them to stay involved in programming and technology. The creation of intelligent assistants on topics of educational content also contributes to a deeper learning of the material in different educational subjects as well as to inter-subject connections. This approach helps students see the practical applicability of their knowledge and realize the connections between different disciplines, which enriches their general education and stimulates their curiosity about science and technology.

Example 2. The second example is from the "Artificial Intelligence—Logical Programming of Prolog" course for eighth-grade students at the Professional High School of

Electrical Engineering and Electronics in Plovdiv. The training is carried out as a STEM subject. Students demonstrate a knowledge base built with Prolog that uses approaches for recording and retrieving animal-related information. To accomplish this, a STEM project was created in which necessary information from a biology textbook was collected and converted into code. The study resources include information on several animal species, classes, families, and other categories. By transforming this data into Prolog facts and rules, students learn how to arrange and organize information in a specific way. They also learn basic biological concepts such as animal taxonomy, characteristics, habitats, and behaviours. In the project, students define facts and create rules to describe the relationships between different animal species and their characteristics. This allows them to develop a better grasp of how knowledge bases are built and used, as well as how to efficiently query those bases to find the information they need. Knowledge base architectures can be organized in a variety of ways, combining logic programming with data storage and management capabilities. Students at this college develop PIs in C# while studying an imperative programming language [2]. The web application connects the user to the database through an easy-to-use interface. Using the ASP.NET framework in this scenario teaches students how to build modern internet applications with the Model-View-Controller (MVC) design, HTML5, databases, Entity Framework Core, and other technologies. The basic steps in creating this project are:

- *Study of information from a given field (biology):* classification of animals, characteristics, their habitat, and other data from the field of biology.
- *Building the fact base:* Once enough information has been gathered, the next step is for students to build the fact base in Prolog. This includes all the basic facts and rules related to animals that will be used in the app itself.
- *Web application interface (Fig. 2):* After the fact base is created, a user interface for the web application should be developed. This interface will allow users to interact with the database and search for information on mammals, for example.

By modelling a logic programming network in Bulgarian secondary education, we can empower students, support teachers, and create a more inclusive and effective learning environment. Let's embrace the potential of AI to transform education and prepare students for the future. This initiative in Bulgaria provides a model for how AI can be effectively integrated into secondary education to improve learning outcomes. By developing and using a logic programming network, educators can introduce students to advanced technological concepts and prepare them for future challenges in the digital age [3, 4]. The article demonstrates the potential of AI to transform educational practices by offering innovative methods, tools, and organizational forms that can be adapted and applied in different educational contexts. As AI continues to develop, initiatives like these will play a critical role in shaping the future of education, making learning more engaging, effective, and accessible to all students.

References

[1] Stoyanov Stanimir N., Tabakova-Komsalova Veneta V. Project Digital Bulgaria in Prolog by examples, VII Международная научная конференция, “Информатизация образования и методика электронного обучения: цифровые технологии в образовании”, 2023 г., стр.1440-1444, Красноярск, Русии, ISBN 978-5-00102-654-9.

[2] Amruth N. Kumar. 2002. Prolog for imperative programmers. J. Comput. Sci. Coll. 17, 6 (May 2002), 167–181.

[3] Meng, N., Dhimolea, T.K., Ali, Z. (2022). AI-Enhanced Education: Teaching and Learning Reimagined. In: Albert, M.V., Lin, L., Spector, M.J., Dunn, L.S. (eds) Bridging Human Intelligence and Artificial Intelligence. Educational Communications and Technology: Issues and Innovations. Springer, Cham. https://doi.org/10.1007/978-3-030-84729-6_7

[4] Ouyang, F., Wu, M., Zheng, L. et al. Integration of artificial intelligence performance prediction and learning analytics to improve student learning in online engineering course. Int J Educ Technol High Educ 20, 4 (2023). https://doi.org/10.1186/s41239-022-00372-4.