PAISII HILENDARSKI
UNIVERSITY OF PLOVDIV
1961

‘Digital Bulgaria in Prolog’

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PROJECT GOAL

A selection of interesting artefacts, events, traditions from our cultural-historical heritage, folklore and history and their formal modelling with the means of logic programming and in particular with the logic programming language Prolog.

Bulgaria is a country of ancient history, remarkable cultural and historical heritage, folklore traditions and natural wonders. The idea of the project is to select interesting artefacts, events, traditions from our cultural-historical heritage, folklore and history and these artefacts to be modelled in a formal way with the means of logic programming and in particular with the logic programming language Prolog. Also, our natural features and geographical phenomena will be included in the project's knowledge base.

The project logo

A logo has been prepared to present the project,
which is described as Bulgarian embroidery.

BACKGROUND STORY

- Introducing the study of artificial intelligence (AI) in secondary schools
- Logic programming and Prolog
- Prolog and Artificial Intelligence

Recently, there have been increasing efforts worldwide to introduce the study of artificial intelligence (AI) into secondary schools. European countries have been striving to take a leading position in technological development in the field of AI and take care of its rapid and comprehensive implementation in their economy.
Logic programming is a programming model that is heavily used in some areas of artificial intelligence. Prolog was one of the first logical programming languages and has had a significant impact on AI since its inception. Prolog describes complex ideas in a simple and declarative way. In Prolog, knowledge is defined as facts, rules, and goals that are well-suited to solving AI problems. Prolog excels in artificial intelligence, natural language processing, expert systems, and constraint programming. With its powerful pattern matching and rule-based inference capabilities, Prolog can handle complex problems that are challenging to solve using other programming languages. Prolog's logical underpinnings make it well-suited to modelling human reasoning, which is why our team believes it is well-suited for introducing AI into the middle school. We have offered several schools a curriculum with core topics including logic programming based on the Prolog language.

Our three-year experience

- National Program for Innovation in Secondary Education
- STEM centres
- A curriculum involving logic programming based on the Prolog language
- The Prolog Education and Thinking Initiative
- Implementation of the project
- Teacher training

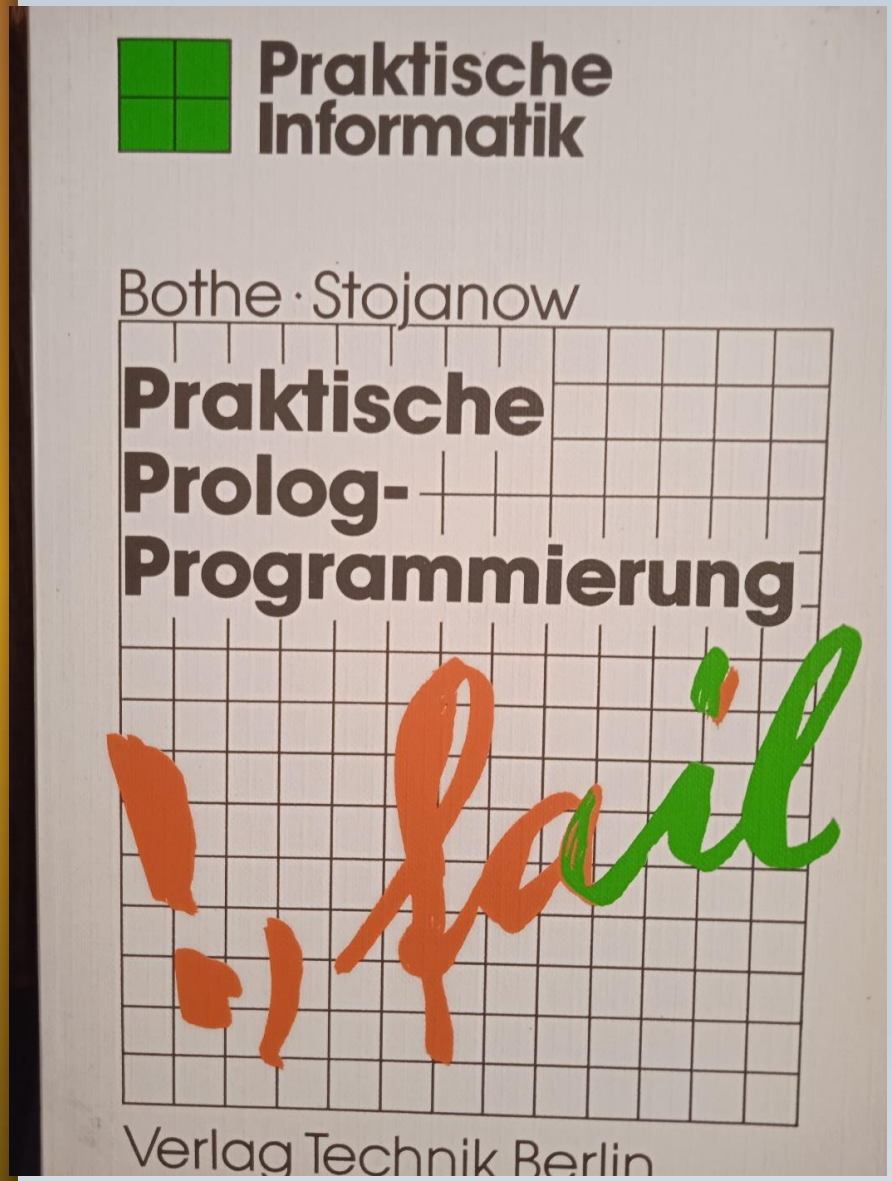
№	Topic
Section 1: Introduction to Artificial Intelligence (AI)	
1.	Definition of AI. Origin and history.
2.	Modern AI. Artificial intelligence and logic programming
Section 2: Knowledge	
4.	Knowledge in the field of artificial intelligence. Specialized and general knowledge.
5.	Presentation of knowledge. Representation of knowledge through rules.
Section 3: Logic	
9.	Logic. Basic concepts of mathematical logic. Deductive logic – basic concepts, syntax and semantics.
10.	Predicate logic. Presenting knowledge with common sense.
Section 4: Logic programming language Prolog	
11.	Logic programming and Prolog. Why Prologue? History. Applications.
12.	Theoretical foundations of the Prolog language. Facts, rules and goals.
13.	Getting to know SWI-Prolog. Examples
14.	Introduction to the Prolog programming language. Unification.
15.	Introduction to the Prolog programming language. Resolution.
16.	Return mechanism. Operator cut (!).
17.	Arithmetic expressions and operators.
18.	Working with data structures in the Prolog language. Lists.
19.	Lists. Basic operations.
20.	Predicates that handle lists. Examples.
21.	Knowledge-based systems. Knowledge base. Inference machines.
22.	Development of an independent project. Main stages.

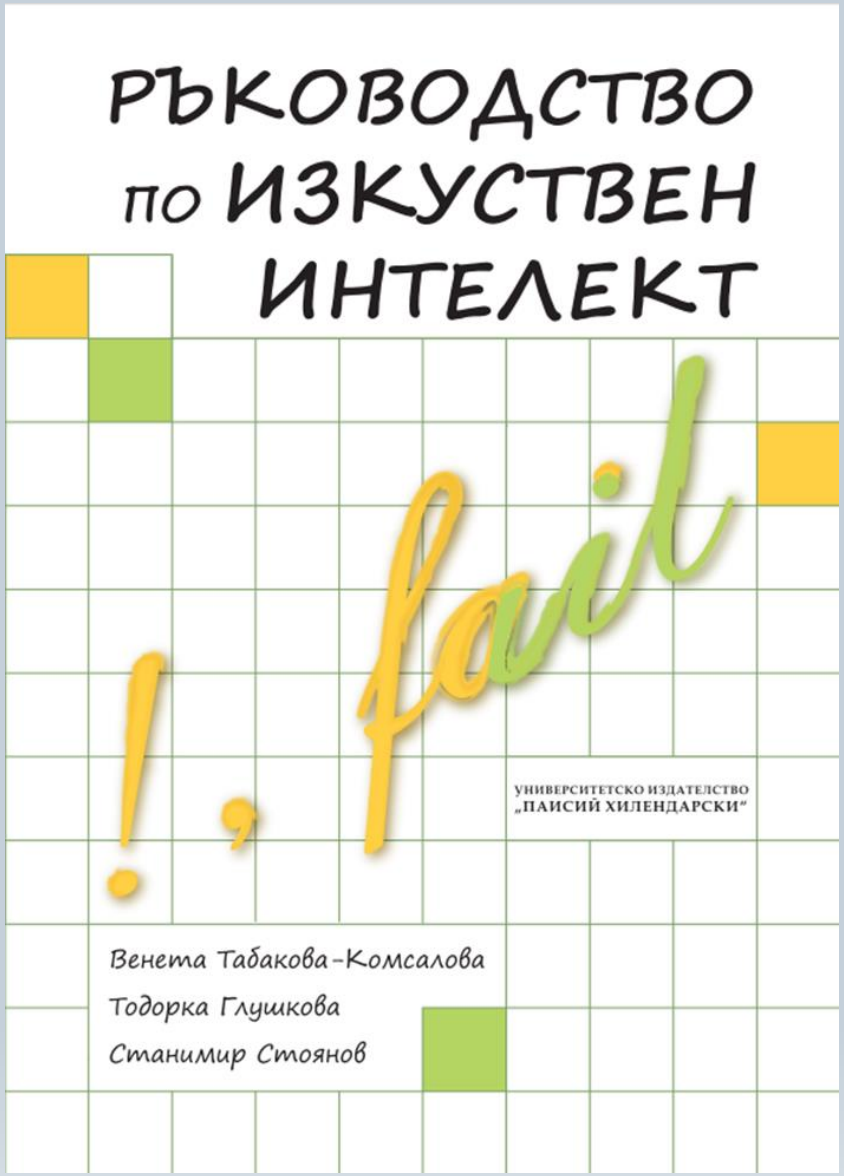
Recently, more and more efforts have been made worldwide to introduce the study of artificial intelligence (AI) into secondary schools. A strategy for the development of artificial intelligence in Bulgaria until 2030 has been published, including artificial intelligence in education and science.

Our team actively participates in activities related to the study of artificial intelligence in secondary schools. We have proposed a curriculum involving logic programming based on the Prolog language. We have three years of practical experience in implementing the program in some schools in the region of the city of Plovdiv. We get new incentives in connection with Professor Kowalski's invitation to join the ‘Prolog Education and Thinking’ initiative, launched on the occasion of the 50th anniversary of the creation of the Prolog language. Joining this initiative, we have proposed a national project called ‘Digital Bulgaria in Prolog’.

The implementation of the project involves various types of activities, such as the need to develop a suitable curriculum. The current program, according to which we started the training, is shown in the Figure.

Prolog training and books



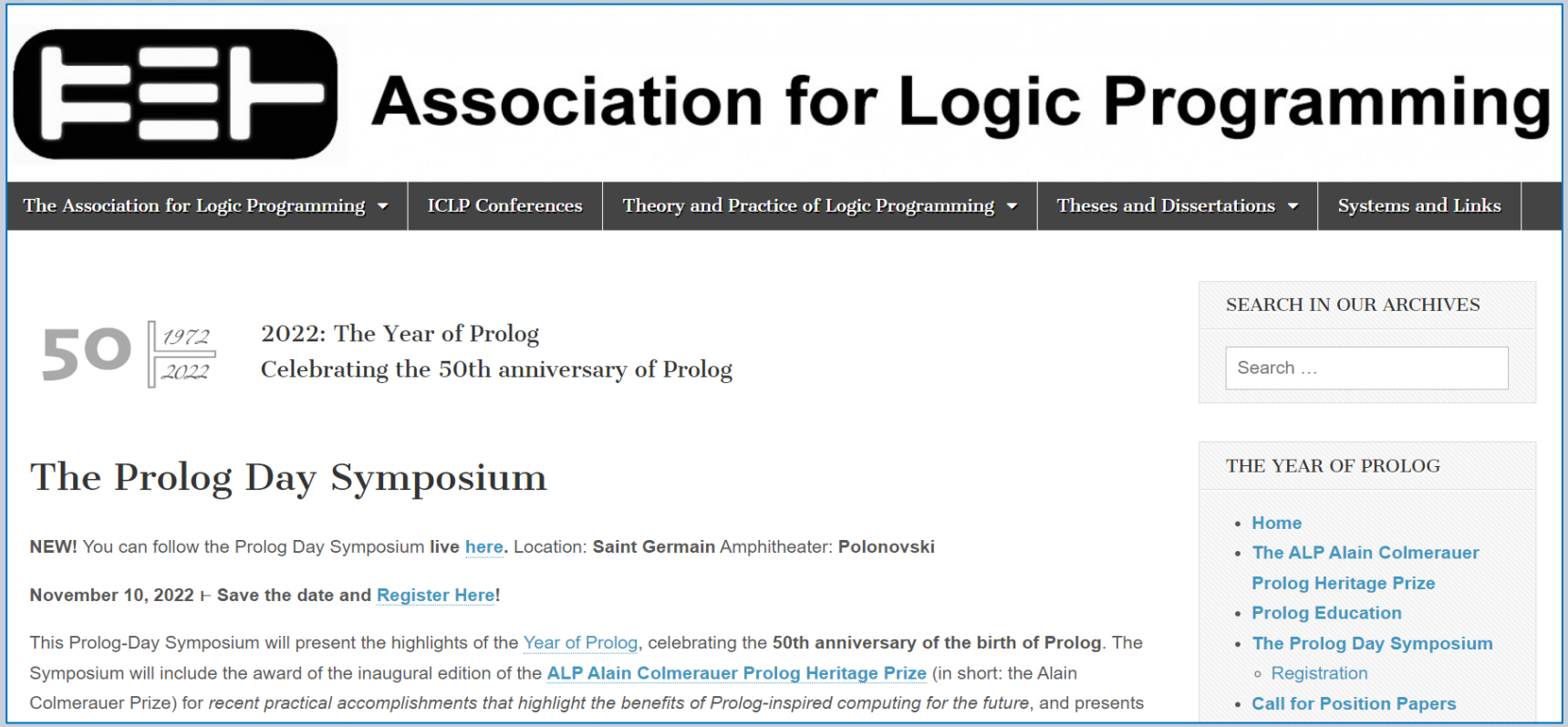


The program we offer for secondary school is based on practice with students in the 'Introduction to AI' subject at the Faculty of Mathematics and Informatics of the University of Plovdiv.

The practice in this subject is taught in the Prolog language and a teaching aid has been issued. In this tutorial, we use some of the examples in the featured book.

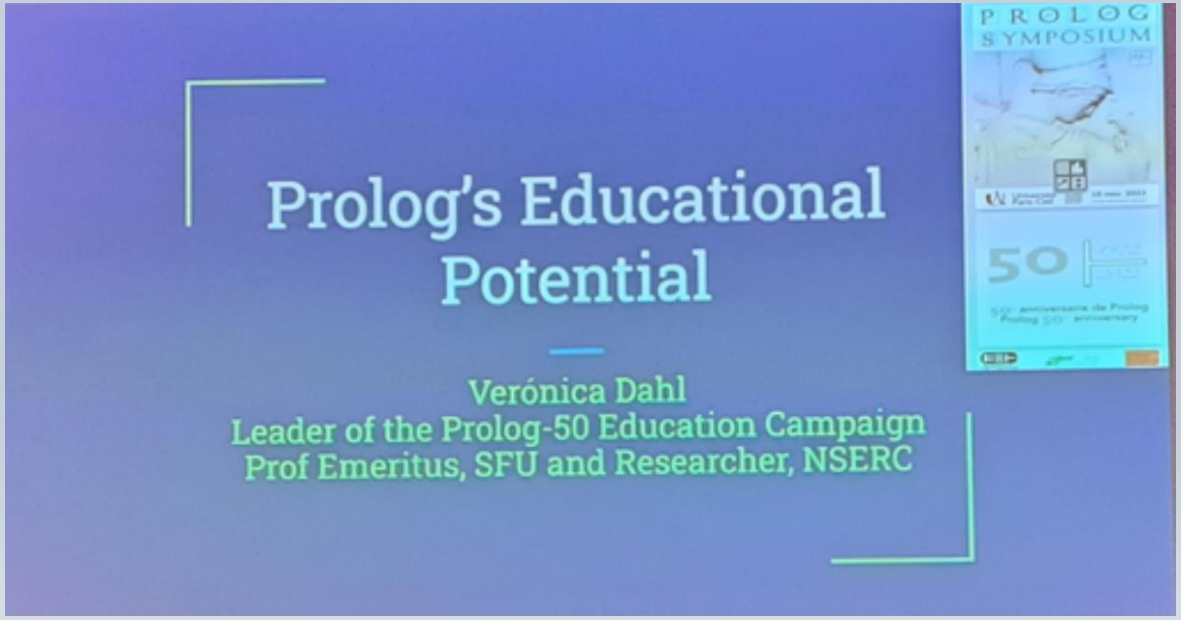
Prolog50 initiative

- Invitation by Robert Kowalski and participation in:
  - Online meeting
  - Symposium in Paris



On the idea of Prof. Robert Kowalski, in connection with the 50th anniversary of the creation of the Prolog language, the ‘Prolog Education and Thinking’ initiative was launched. This initiative aims to inspire a new generation of schoolchildren and university students by introducing them to a human-friendly, logic-based approach to computing. Joining this initiative, we proposed a national project called ‘Digital Bulgaria in Prolog’. Our team took part in The Prolog day Symposium in Paris dedicated to 50 years since the creation of the Prolog language.

Moments from the symposium in Paris



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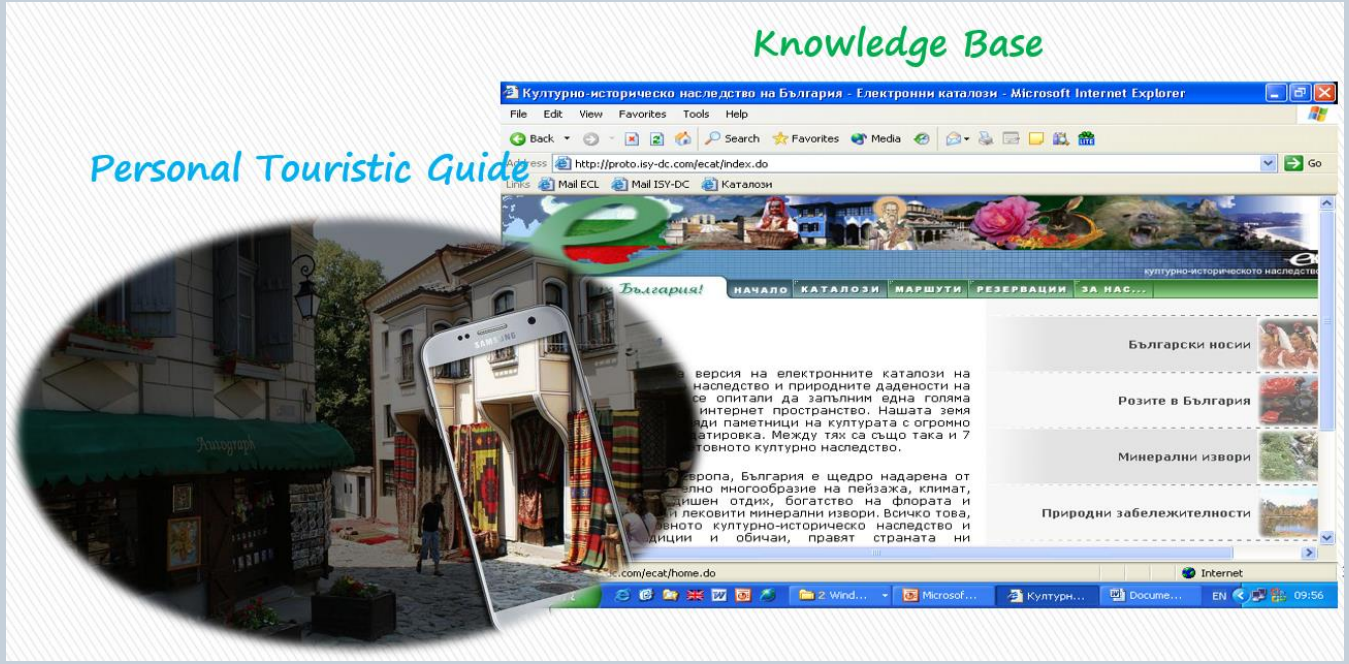
Objectives of the initiative

- Creating a network of schools
- Preparation of projects
- Participation in the global initiative ‘Prolog Thinking and Education’

By participating in this initiative we are getting involved with this project and participating in the introduction of Prolog training in the secondary school through the STEM centres.

The Nature of the project



- Main goal
- The logical approach and the Prolog language
- Architecture of the project's software
  - ✓ distributed knowledge base
  - ✓ personal tourist guide

The main goal of the project is to support the introduction of the subject in the Bulgarian secondary school under different educational forms, including in STEM centres. The project was developed in such a way as to allow the inclusion of a large number of schools in its implementation. First meetings have already been held with schools that have expressed a desire to become partners in the project. At the same time, the project remains open to the inclusion of new participants.

The logical approach (and the Prolog language) is fundamental to knowledge modelling. Also, Prolog programming is easy and understandable because it is close to natural language. All this motivates us to choose the Prolog language as the main tool for implementing the presented in this project.

Architecture

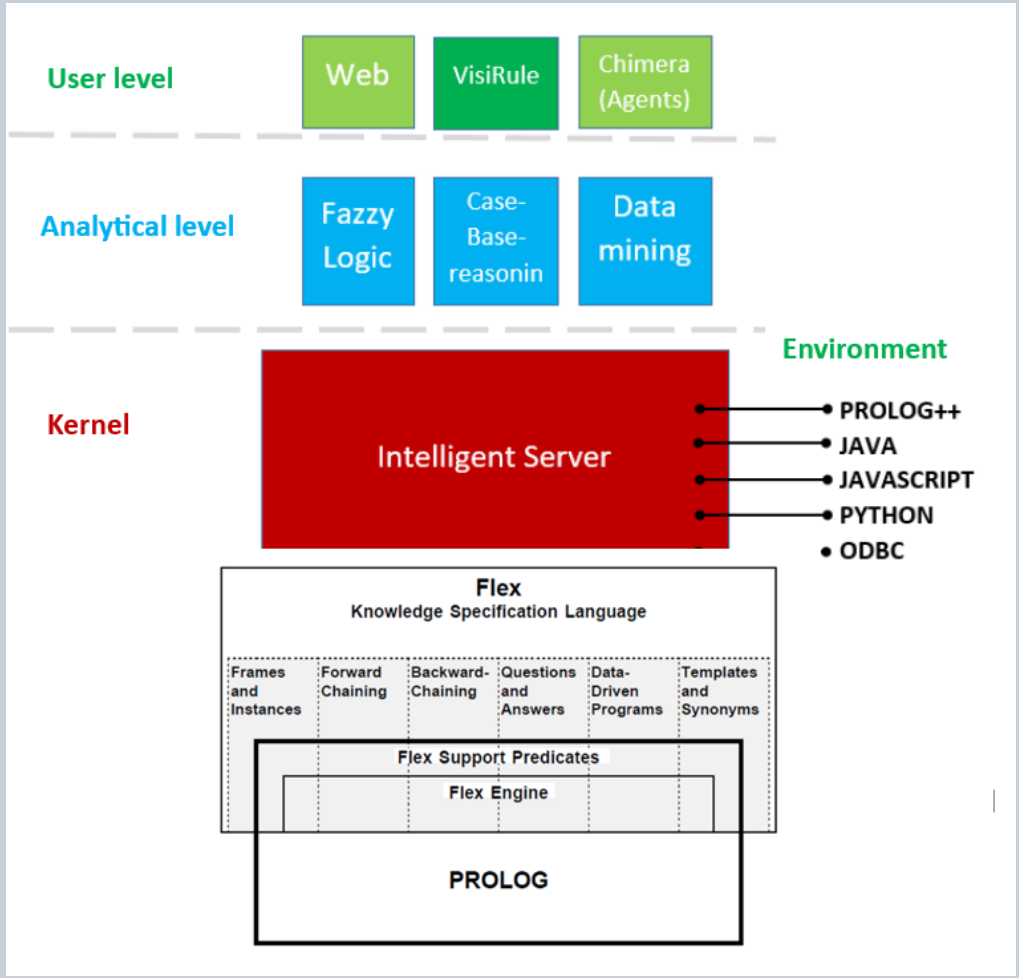
The overall architecture of the system that will be developed within the project consists of two main components – a distributed knowledge base and a personal tourist guide shown in the figure.

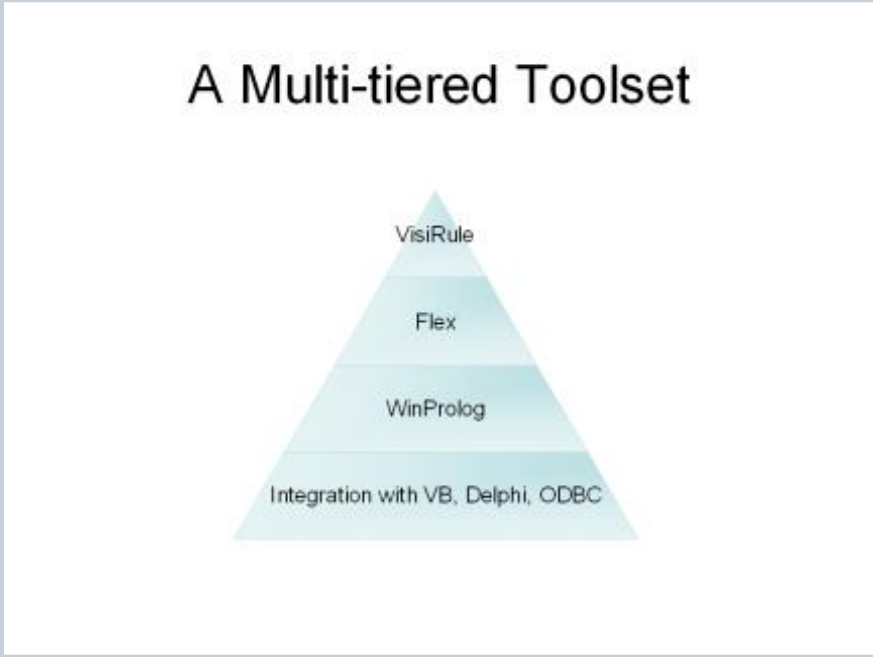
The modules will be structured in separate thematic areas

Cultural-historical heritage

- Historical sites;
- Architectural objects;
- Ethnographic objects;
- Folk crafts;
- Book and literary values;
- Customs, rites, celebrations, rituals and beliefs;
- Music, songs and dances
- And other.

Flex





The Flex system fits into the LPA software package. Flex is fully implemented in Prolog and is designed specifically to allow the easy development of expert systems.
Flex has a three-tier architecture: KSL, flex support predicates, and the flex engine. KSL sits on top of Prolog and the flex support and flex engine predicates are integrated directly into Prolog.

Project ideas in Prolog examples

The first is dedicated to Bulgarian folklore and more precisely to Bulgarian needlework. Bulgarian folklore and more precisely to Bulgarian needlework. We present embroidery in the form of a game, which includes knowledge of fine art, mathematics, folklore.


```
% Класификации носии
% тип_носия(Област, Пол)
% -------------------------
тип_носия(добруджанска,жена).
тип_носия(северняшка,жена).
тип_носия(пиринска,жена).
тип_носия(родопчанска,жена).
тип_носия(странджанска,жена).
тип_носия(тракийска,жена).
тип_носия(добруджанска,мъж).
тип_носия(северняшка,мъж).
тип_носия(пиринска,мъж).
тип_носия(родопчанска,мъж).
тип_носия(странджанска,мъж).
тип_носия(тракийска,мъж).
```

```
% Части на народните носии
% части_носия(Област, Части)
% -------------------------------
части_носия(родопчанска,[риза,сукман,мерсжан,престилка,кърпа_глава,кърпа_снага,пояс,чорапи,цървули]).
части_носия(добруджанска,[риза,сукман,мерсжан,престилка,кърпа_глава,кърпа_снага,пояс,чорапи,цървули]).
части_носия(северняшка,[риза,сукман,мерсжан,престилка,кърпа_глава,кърпа_снага,пояс,чорапи,цървули]).
части_носия(пиринска,[риза,сукман,мерсжан,престилка,кърпа_глава,кърпа_снага,пояс,чорапи,цървули]).
части_носия(странджанска,[риза,сукман,мерсжан,престилка,кърпа_глава,кърпа_снага,пояс,чорапи,цървули]).
части_носия(тракийска,[риза,сукман,мерсжан,престилка,кърпа_глава,кърпа_снага,пояс,чорапи,цървули]).
% Други характеристики
% герб_род(Герб,Област,Пол).
% цвят_вълненик(Област,Цвят).
% ---------------------
герб_род(точно_определена_украса,родопчанска,жена).
герб_род(не_идентифициран,родопчаска,мъж).
цвят_вълненик(родопчанска,черен).
цвят_вълненик(родопчанска,тъмно_син).
цвят_вълненик(родопчанска,червен).
```

SWISH File Edit Examples Help

Program +

```
% ***********************************************
% ПРОЕКТ: Digital Bulgaria in Prolog            %
% ===============================================%
% Модул: ГЕОГРАФИЯ                              %
% Тема: Реките на България                      %
% ***********************************************
влива_се_в(дунав,черно_море). влива_се_в(камчия,черно_море). влива_се_в(велека,черно_море).
влива_се_в(резовска_река,черно_море). влива_се_в(хаджийска_река,черно_море). влива_се_в(марица,бяло_море).
влива_се_в(струма,бяло_море). влива_се_в(места,бяло_море). приток(искър,дунав).
приток(осъм,дунав). приток(янтра,дунав). приток(тимок,дунав). приток(вит,дунав).
приток(огоста,дунав). приток(лом,дунав). приток(тунджа,марица). приток(арда,марица).
приток(тополница,марица). приток(въча,марица). приток(стряма,марица). приток(чепеларска_река,марица).
приток(чепинска_река,марица). приток(луда_река,марица). приток(луда_яна,марица). приток(пясъчник,марица).
приток(стара_река,марица). приток(росица,янтра). приток(стара_река,янтра). приток(белица,янтра).
приток(малки_искър,искър). приток(лесновска_река,искър). приток(златна_панега,искър). приток(бели_осъм,осъм).
приток(черни_осъм,осъм). приток(команска_река,осъм). приток(суха_река,осъм). приток(дрипла,осъм).
приток(видима,росица). приток(росица,янтра). приток(веселина,стара_река).

водосборен_поток(Река1,Река2) :-    приток(Река1,Река2).
водосборен_поток(Река1,Река2) :-    приток(Река1,Р), водосборен_поток(Р,Река2).

тече_към_море(Река,Море) :- влива_се_в(Река,Море).
тече_към_море(Река,Море) :- водосборен_поток(Река,Р), влива_се_в(Р,Море).

море(Море) :- влива_се_в(_,Море).

река(Река) :-   приток(Река,_).
река(Река) :-   приток(_,Река).
река(Река) :-   влива_се_в(Река,_).

% ?- тече_към_море(марица,Море).
% ?- тече_към_море(Река,черно_море).
% ?- водосборен_поток(Река,марица).
% ?- море(Море).
% ?- река(Река).
% ?- влива_се_в(Река,_).
% ?- приток(_,Река).
% ?- приток(Река,_).
```

Geographical objects - Rivers of Bulgaria

тече_към_море(Река,черно_море).

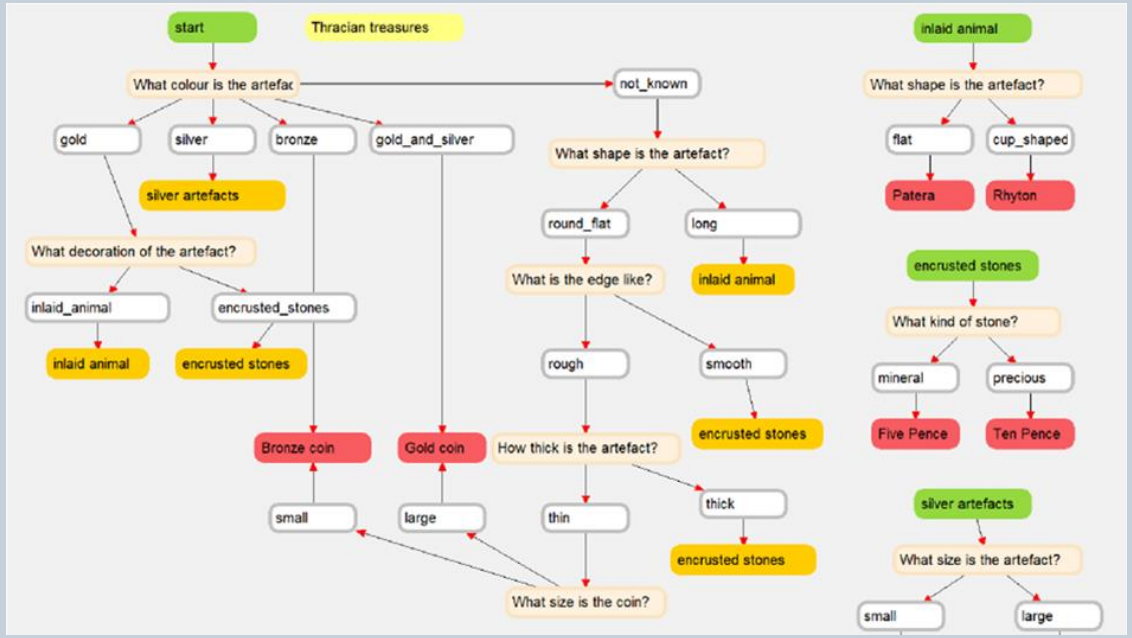
Река = дунав
Река = камчия
Река = велека

Next 10 100 1,000 Stop

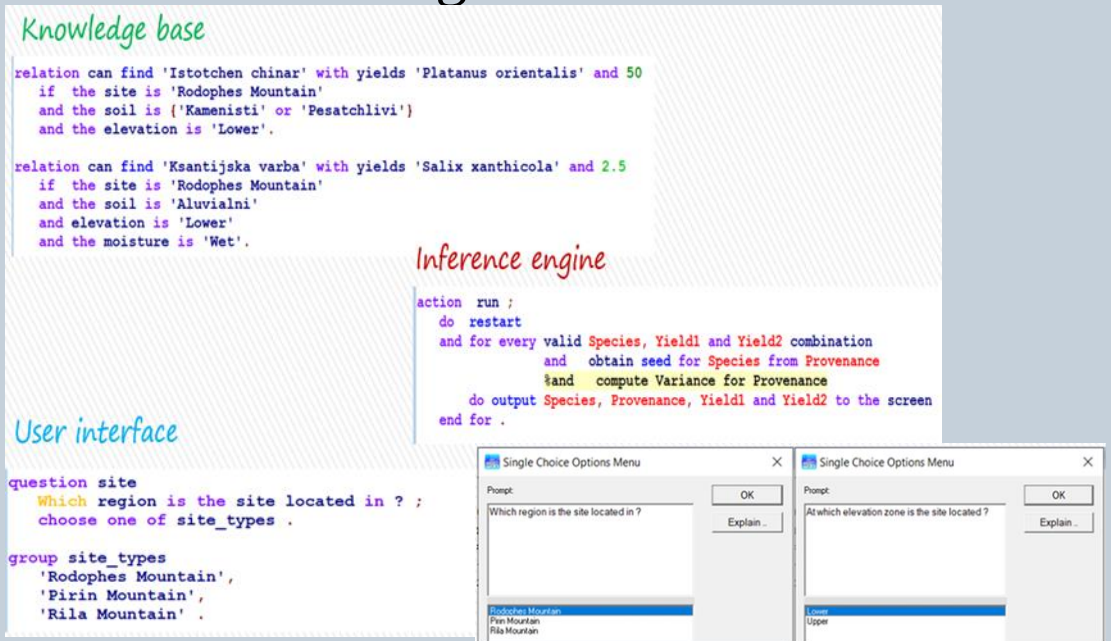
?- тече_към_море(Река,черно_море).

Project content by examples

Historical sites The Thracian Treasures presented via VisiRule.



Natural objects presented by us on FLEX through KSL ‘A small interactive e-book about the Bulgarian forest’.



Project ideas in examples

A combination of Chemistry, Physics, Geography, Mathematics and Informatics - MINERAL WATERS

```
% %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%                                           %
% PROJECT: Digital Bulgaria in Prolog       %
% =================================         %
% Module: The mineral springs of Bulgaria   %
%                                           %
% %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Characteristics of mineral springs
% Predicate: mineral_spring(Spring, [T,M,PH,HCO3,SO4,CI,Na]).
%
% Database
mineral_spring(izvoriste, [24,460,7.8,256,34,15,84]).
mineral_spring(velingrad, [22,1976,9.15,24,26,4,50]).
mineral_spring(devin, [44,223,9.4,101,20,2,70]).
mineral_spring(bankia, [20,417,7.3,297,10,3,16]).
mineral_spring(sapareva_bania, [57,707,9.4,116,244,30,212]).

% Класификация на минералните води според температурата
cold(Spring) :-
    mineral_spring(Spring, [T,_,_,_,_,_,_]),
    T < 37.
warm(Spring) :-
    mineral_spring(Spring, [T,_,_,_,_,_,_]),
    T > 37, T =< 60.
hot(Spring) :-
    mineral_spring(Spring, [T,_,_,_,_,_,_]),
    T > 60.
```

```
% Classification of mineral waters according to chemical composition
poorly_mineralized(Spring) :-
    mineral_spring(Spring, [_,M,_,_,_,_,_]),
    M =< 2.
moderately_mineralized(Spring) :-
    mineral_spring(Spring, [_,M,_,_,_,_,_]),
    M > 2, M =< 15.
loud_mineralized(Spring) :-
    mineral_spring(Spring, [_,M,_,_,_,_,_]),
    M > 15, M =< 30.
salted(Spring) :-
    mineral_spring(Spring, [_,M,_,_,_,_,_]),
    M > 30, M =< 60.
heavily_salted(Spring) :-
    mineral_spring(Spring, [_,M,_,_,_,_,_]),
    M > 60.
```

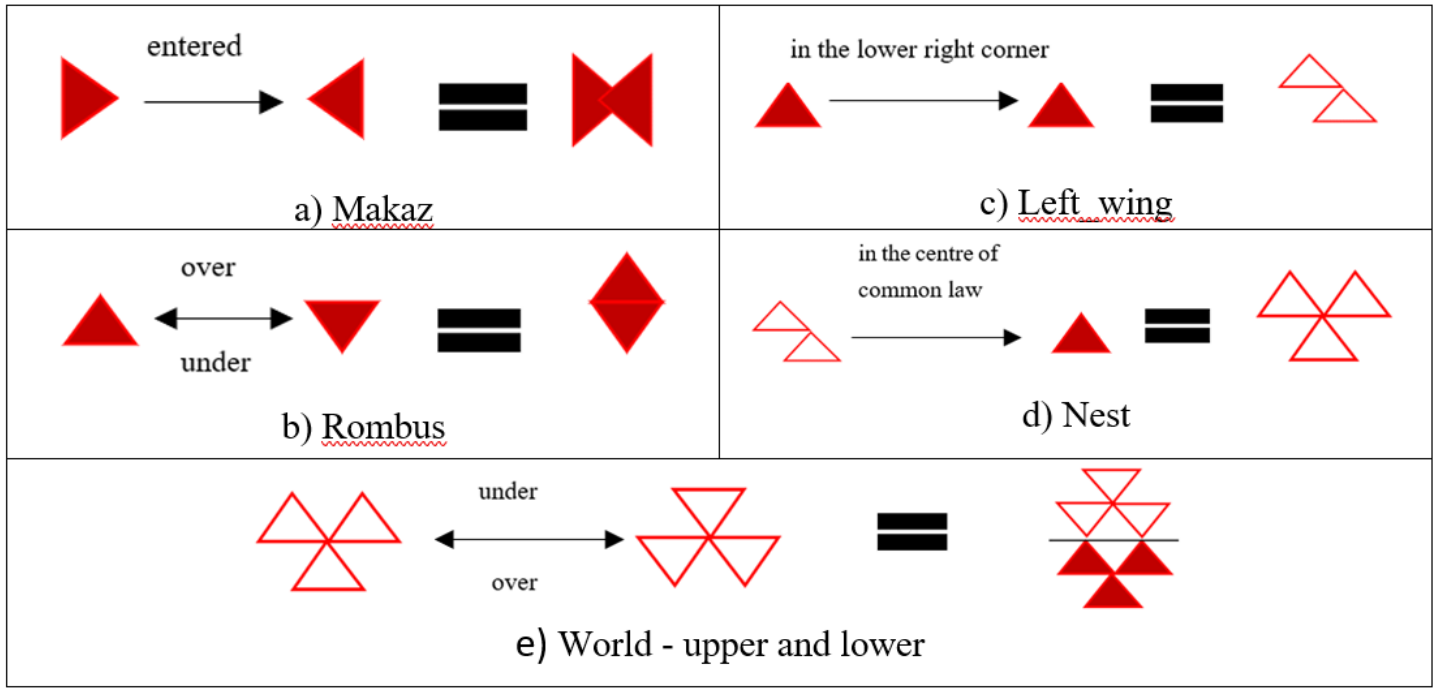
```
cold(Spring)
Spring = izvoriste
Spring = velingrad
Spring = bankia
false

?- cold(Spring)
```

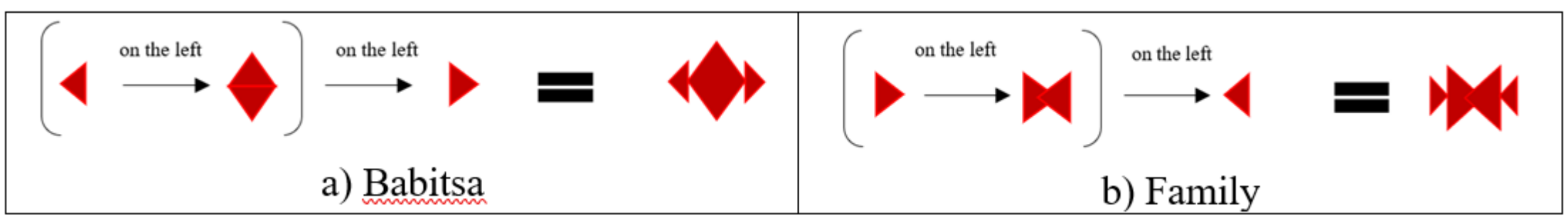
Modelling of knowledge in the field of Bulgarian folklore

Example ‘Bulgarian embroidery’

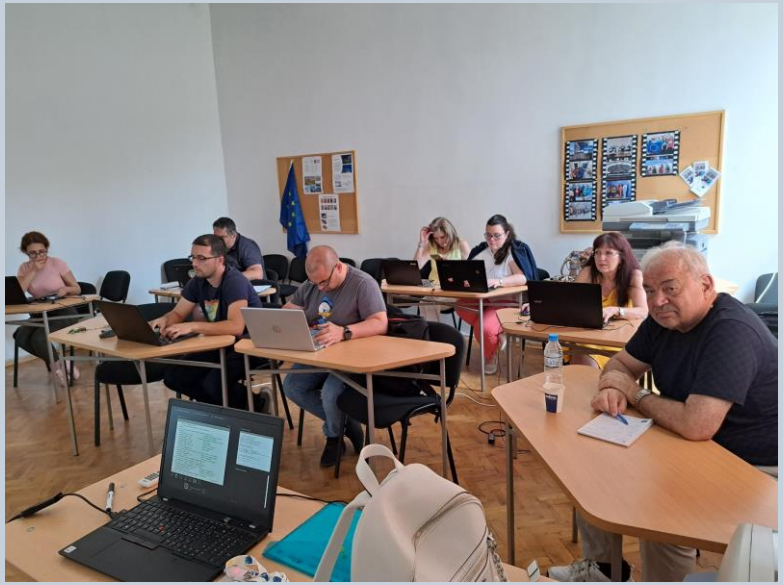
- Relations over Folklore Primitives and Folklore Elements from the first level

- Relations over Folklore Elements





Training teachers to teach the curriculum



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Conclusion

- Inspiring the new generation of students
- Increasing interest in other academic disciplines, such as history and geography of Bulgaria, Bulgarian cultural and historical heritage, Bulgarian folklore.
- Introduction of Artificial Intelligence in secondary schools

The implementation of the project will inspire a new generation of students by introducing them to a convenient, logic-based programming language and increasing their interest in the cultural and historical heritage of Bulgaria. In addition, students will acquire knowledge related to other subject areas they study (history, geographers, etc.) and how this knowledge can be represented in intelligent systems. The implementation of the project will also stimulate creative and abstract thinking of students. We see this project as a continuing effort to introduce AI education in secondary school.