

# Intelligent and Adaptive Quizzes for semi-automatic Monitoring of Student Preparation

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# Context and Motivations

- **Moodle** and other Learning Management Systems (LMSs) have become very successful in e-Education
- But there is less attention in some important facilities:
  - providing **quizzes adaptivity** based on the level of knowledge of Students
  - providing **automatic assistance** for evaluators when building an exam
- We propose two potential solutions to overcome this:
  - “**Adaptive Quiz**”
  - “**Score Assistant**”
- Both solutions heavily rely on **Logic-based Artificial Intelligence**

# Artificial Intelligence

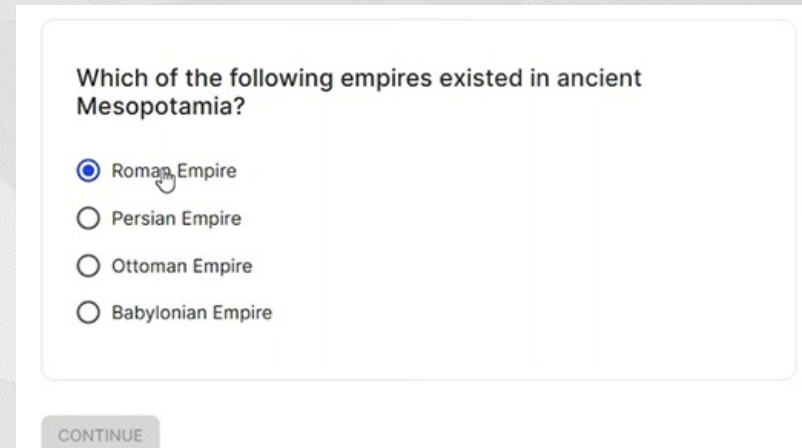
- Two paradigms of Artificial Intelligence (AI) can be identified:
  - **Inductive Reasoning: *Machine Learning / Deep Learning***
    - **Pros:** Automatic Learning of Patterns starting from data
    - **Cons:** Big Data and High Computational power needed for the training process, **error prone**
  - **Deductive Reasoning: logic-based**
    - **Pros:** Applying **common sense reasoning**, **no errors** (100% reliability)
    - **Cons:** Not dynamic and unable to learn new Knowledge from data

# Our Proposals (1)

## “INTELLIGENT AND ADAPTIVE QUIZ”

### QUIZ WITH INTELLIGENT ADJUSTMENT OF DIFFICULTY

Quiz difficulty **changes automatically while answering**. The system automatically suggests subsequent questions taking into consideration the current estimated preparation of the students.



Which of the following empires existed in ancient Mesopotamia?

- Roman Empire
- Persian Empire
- Ottoman Empire
- Babylonian Empire

CONTINUE


1. A student starts answering a given quiz by responding to initial questions.
2. An intermediate TKS is computed after responding to each question, by evaluating the correctness of given responses.
3. By taking into account the intermediate TKS, the system automatically selects the next **best questions** to be proposed to the student.

# Our Proposals (2)

## “SCORE ASSISTANT FOR EDUCATORS” AUTOMATIC ASSIGNMENTS OF SCORES

The *Score Assistant* is an intelligent tool that computes **optimal scores** to be set to a quiz, helping educators during the quiz building process.

1. The educator chooses a relevance value for each topic and assigns each question to a topic.
2. The *Score Assistant* considers the given relevance for automatically suggesting potential optimal scores for each question.

 COMPUTE OPTIMAL SCORES

Geography

40

0% max 100%



The following optimal scores have been computed:

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Which city is the capital of Canada?

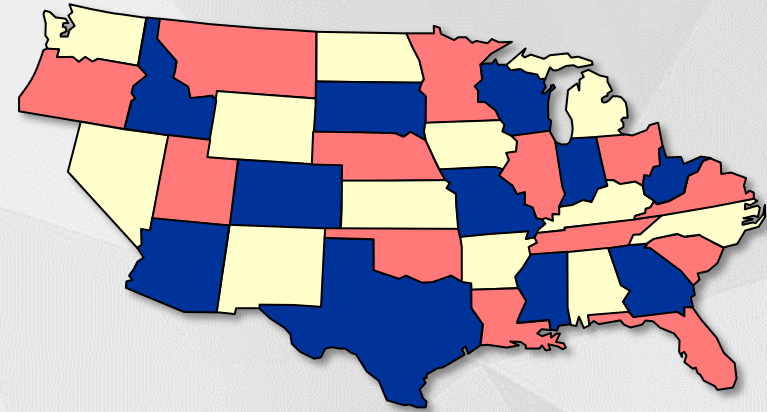
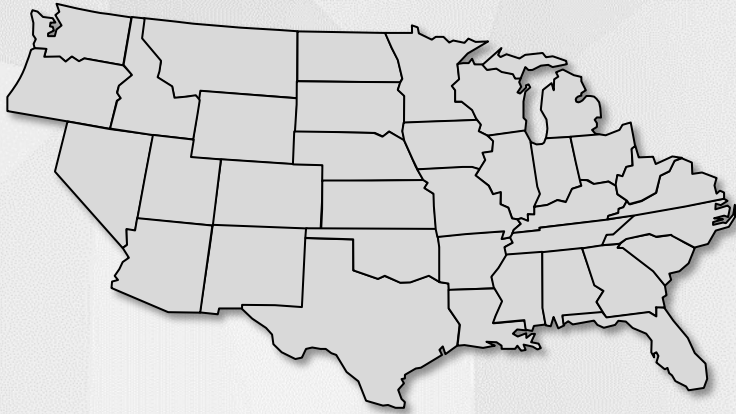
Ottawa **score from 1 to 3**

Montreal 0

# Our solutions are based on Answer Set Programming (ASP)

- **A Declarative Logic Programming**
  - **No need to write the algorithm.**  
We give the burden of resolving the problem to the machine
- **ASP-based Approach**
  - Business and Data Understanding
  - Modeling
  - ~~Development~~
  - Testing
- **Why?**
  - Low implementation costs
  - Fast prototyping
  - Encoding readability
  - Flexibility and Extensibility
  - Efficient execution
  - Low maintenance costs

# ASP by Example: 3 Colorability



## The ASP Program

```
color (X, red) | color (X, green) | color (X, blue) :- state (X).  
:- border (X, Y), color (X, C), color (Y, C).
```

# Adaptive Quiz in Moodle – The ASP Program

% Guess a new question to ask

newQuestion(Q) | notNewQuestion(Q) :- question(Q, Text, Topic, MaxScore), not givenQuestion(Q).

% Minimize the number of new questions to ask

:~ newQuestion(Q). [1]

% Preferably, all the topics should be considered

:~ topic(Topic), question(\_, \_, Topic, \_), not touchedTopic(Topic). [1]

% If exists some topic in which the TKS was previously lower than the average max, and, with the new questions, the new TKS still remains lower than the average max, then try to minimize the difference between the new TKS and the average TKS max

:~ topic\_with\_tks\_lower\_of\_average(Topic), topic\_lower\_avgMax(Topic, X), tks\_avg\_max(AVG\_MAX), Diff = AVG\_MAX - X.  
[Diff]

% If exists some topic which the TKS was previously lower than the average max, and, with the new questions, the new TKS goes over the average max, then try to minimize the difference between the new TKS and the TKS max

:~ topic\_with\_tks\_upper\_of\_average(Topic), topic\_lower\_avgMax(Topic, X), tks\_avg\_max(AVG\_MAX), tks\_max(M), Diff = M - X. [Diff]in



# Score Assistant in Moodle – The ASP Program

% Guess the score to be assigned to every choice

```
{ score(ID_Q, ID_C, SCORE, TOPIC) } :- question(ID_Q, _, TOPIC) , choice(ID_C, ID_Q, _, 1) ,  
                                     chosen_score(SCORE).
```

% a single score must be assigned to every choice

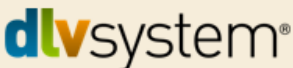
```
:- score(ID_Q, ID_C, SCORE1, _), score(ID_Q, ID_C, SCORE2, _), SCORE1 != SCORE2.
```

% maximize the relevance of each topic

```
:~ relevance(TOPIC, REL), V = (100-REL). [V@1,TOPIC]
```

# DLV: ASP Programs Execution

- **DLV** was created by the **University of Calabria** and the **Technical University of Vienna**
- **DLV** is currently maintained under license by **DLVSystem S.r.l**, a University of Calabria Spin-Off



We exploit the state-of-the-art Artificial Intelligence techniques and proprietary technologies (DLV system and Knowledge Management tools) to create value for our customers.

**🏢 Target Industries**

Big Data Analytics, IoT, Smart Cities, eTourism, eRecruitment, BioMedics and Document Management.

**🔧 Services & Activities**

Research & Development, Consultancy, IT Services, Licensing.

**🏠 Knowledge Representation & Reasoning**


**Deductive AI (logic based)**

- Declarative Problem Solving
- Planning and Scheduling
- Semantic Information Extraction
- Ontology-based Query-Answering
- Data and Knowledge Integration

**🧠 Machine Learning & Deep Learning**

**Inductive AI (data-driven)**

- Big Data Analytics
- Computer Vision
- Predictive Maintenance
- Sentiment Analysis
- Automatic Quality Control



IA

**🏠 🧠 Combining Deductive and Inductive AI for solving advanced challenging problems.**

## DLV

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DLV is an ASP based Knowledge Representation and Reasoning System (KRR).

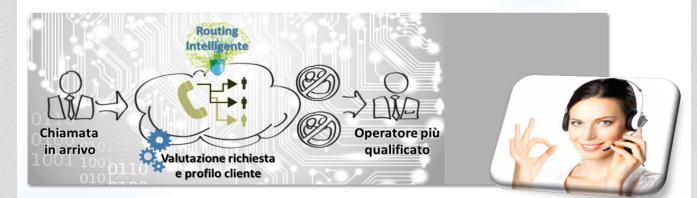
**What are the advantages?**

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- **Powerful language for KRR**  
Captures any problem to solve complex AI tasks
- **Advanced knowledge-modelling features**  
Fast development, easy-to-understand and maintain
- **Solid implementation**  
Database and AI optimization techniques
- **Interoperability**  
RDBMs, RDF triple stores, SPARQL endpoints, etc.
- **Development tools**  
ASPIDE, APIs, RESTful, Docker, etc.

# A selection of success stories

- **Domotics**
  - Optimize energy consumption and costs through intelligent management
- **Workforce Management**
  - The case of Gioia Tauro seaport
- **Intelligent Call Routing**
  - Call centers optimizations
- **e-Recruitment**
  - Best-Match between job offers and resumes
- **Ontologies and Semantic Web**
  - Reasoning over large-scale Knowledge Graphs
- **Deep Learning Integration (Computer Vision)**
  - Automatic check of Electrical Panels



# Conclusions

- We proposed two potential AI solutions for Quizzes:
  - “Adaptive Quiz”
  - “Score Assistant”
- Work in Progress:
  - Implementation of two **plug-ins for Moodle**
  - Establishment of a proficient partnership with Moodle
- We are willing to ***cooperate*** with other companies/institutions to integrate other AI-based solutions in the E-education context

**Contact us**

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The screenshot displays the Moodle SmartForm interface. At the top left, there is a 'SmartForm' header with a small icon. At the top right, there is a '+ NEW FORM' link and a user profile icon labeled 'JS'. Below the header, the main content area shows the title 'SmartForm' followed by a blue button labeled '+ NEW FORM'. Below the button is a light blue informational message box containing an information icon and the text 'You haven't created any form yet.'.