GOALS: **G**enerator **O**f **A**daptive **L**earning **S**cenarios

Interaction traces as knowledge source for the evolution of domain model

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Plan

- System Design
  - Research Context
  - Application Context: Project CLES
  - Objective
  - Contributions
- Experiment
- Perspectives

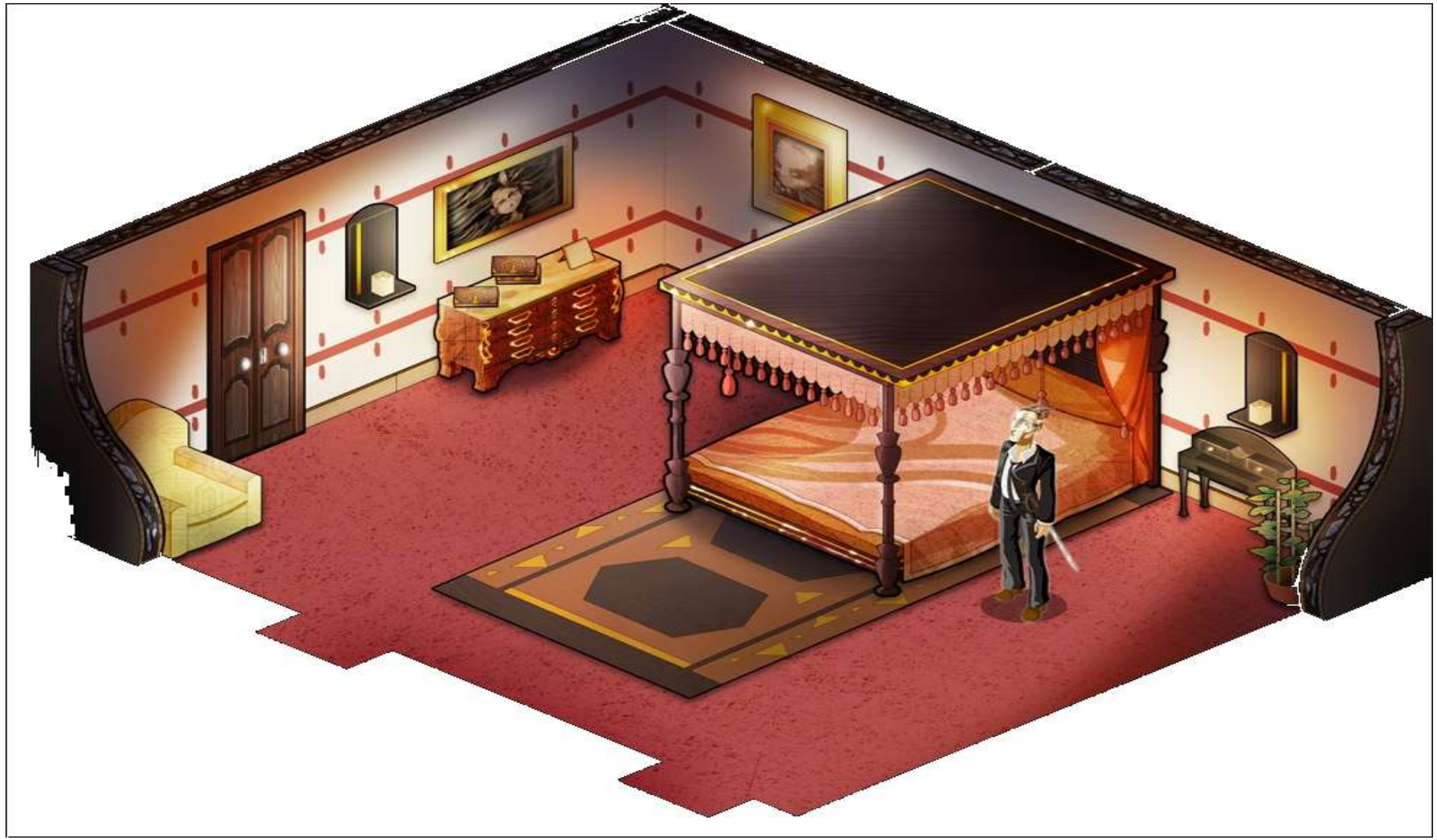
Research Context

- Adaptive Learning Systems – Handicap
  - Adaptation of the learning experience according to the physical and cognitive abilities, competences and skills of the user
  - Taking into account the user in situation of handicap
- Serious Games
  - « a mental contest, played with a computer in accordance with specific rules, which uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives” (Zyda 2005)
  - Principal characteristics: Fun while learning
  - Application domains: Military, Health, Government, Business, Education etc

Application Context: Project CLES

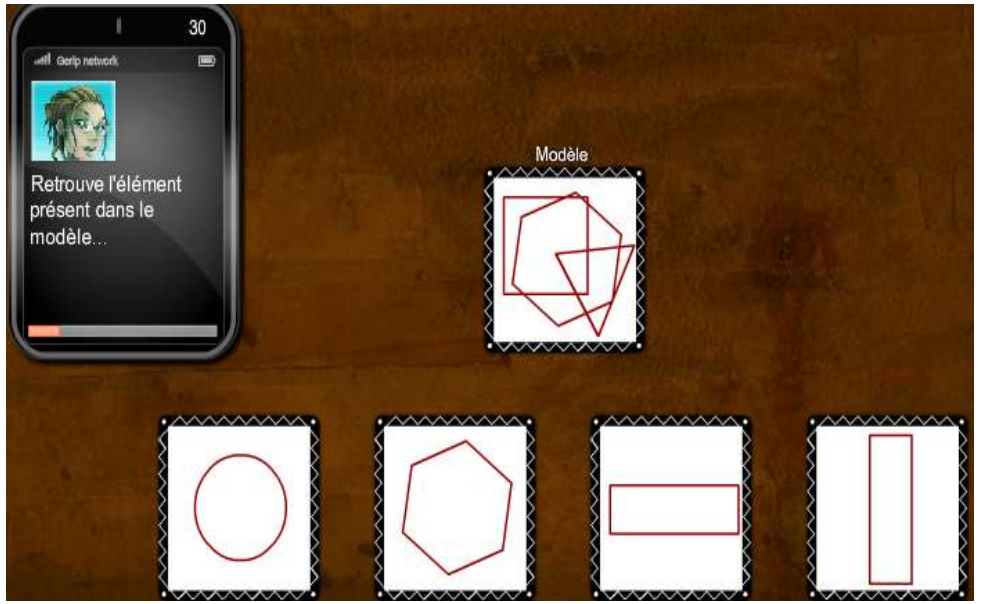
- CLES (Cognitive Linguistic Elements Stimulations)
- Objective
  - To develop an environment of Serious Games for the diagnostics and learning aid of persons in situation of cognitive disabilities.
- Target domains
  - Perception, Attention, Memory, Visual spatial, Language oral & written, Logical reasoning, Diverse competencies
- For each domain: 9 - 12 games with 9 levels of difficulty
- Statistics:
  - 91 mini-games
  - 7.000 users

Application Context: Project CLES



Application Context: Project CLES

- Example of game : Identify intermixed objects
- Domain : Visual Perception



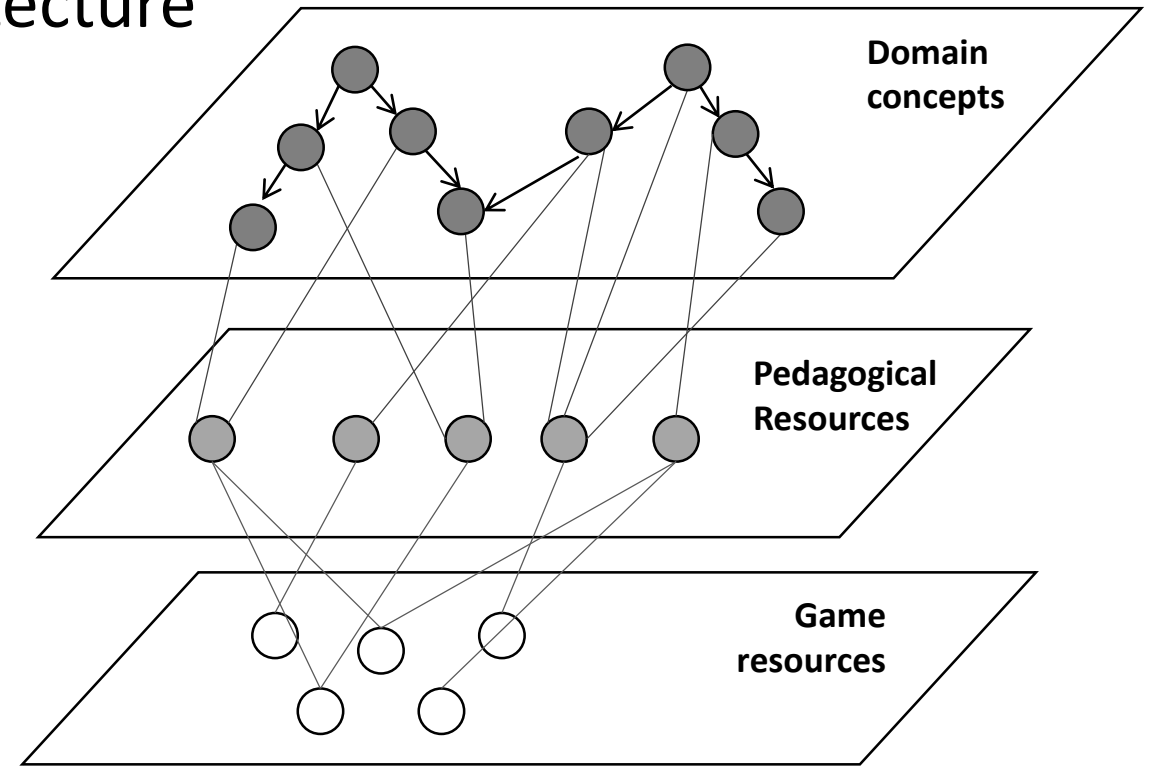
- Parameters
  - Supports, Nb of elements in the model, Nb of responses, Time allowed for response, Element’s complexity

Objectives

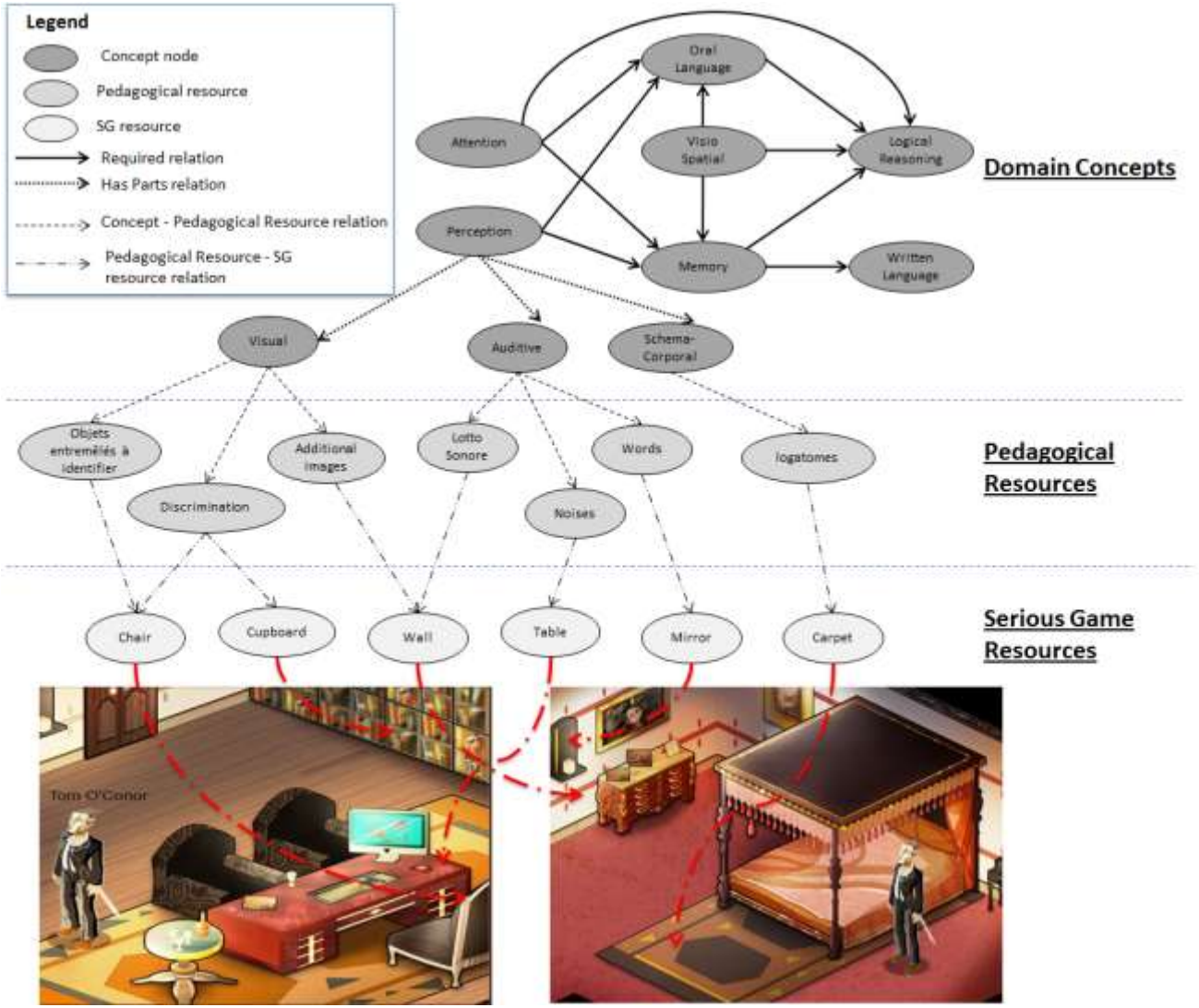
- To propose a generic and scalable system capable of generating adaptive learning scenarios keeping into account the following properties:
  - User’s competencies, skills, preferences and his/her pedagogical goals
  - The ability to be utilized in serious games taking into account its specificities.
  - The use of interaction traces as knowledge sources in the adaptation process.
- To mine the interaction traces for patterns that could assist the expert in:
  - possible reorganization of the domain knowledge, and on the other hand to
  - update the learner profile from its performance.

Knowledge Representation

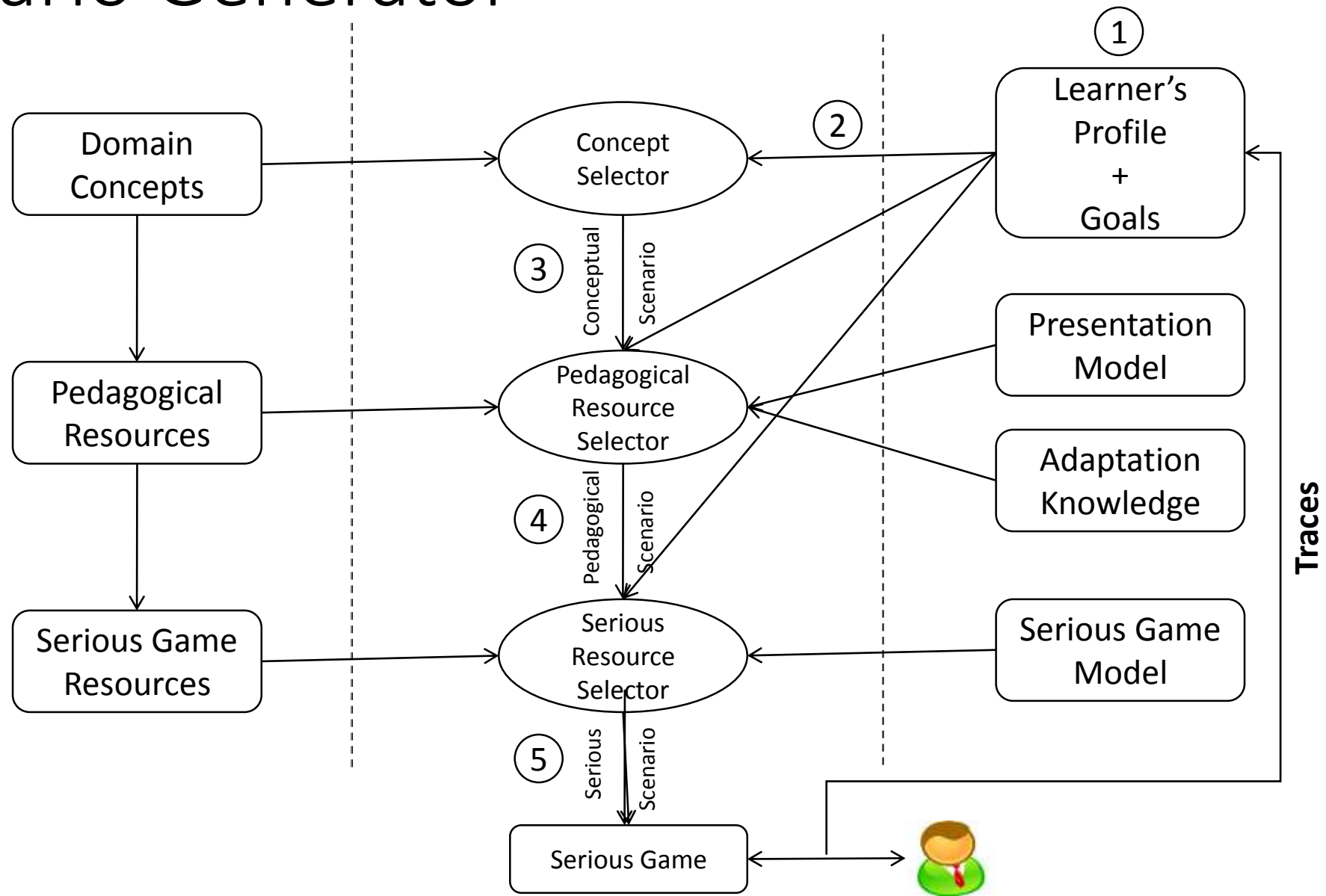
- General Architecture



Knowledge Representation



Scenario Generator



Updating using the interaction traces

- A **trace** is defined as a set of observed elements.
- Formally, a trace 'T' is described as follows:

  $T = \langle start\text{-}time, end\text{-}time, meta\text{-}data, o_1, o_2 \ldots o_n \rangle$

- Formally, an observed element o_i is characterized by the following properties:

  $o_i = \langle rp_i, response_i, time_i, evaluation\text{-}response \rangle$, where

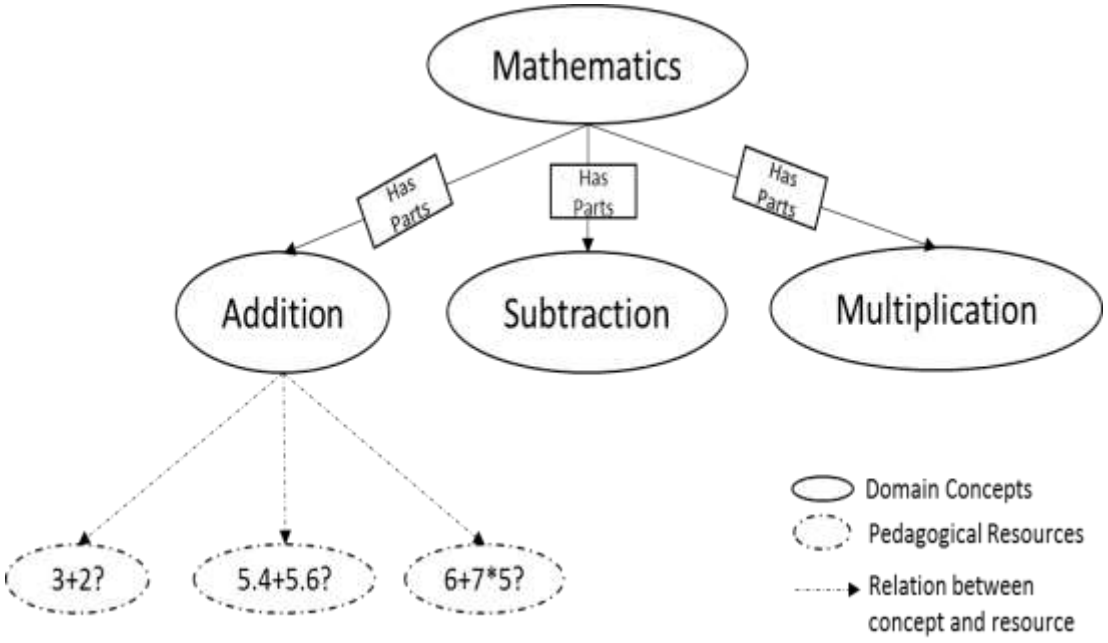
  - **rp_i :** the game resource with which the learner has interacted;
  - **$response_i$** : the response given by the learner;
  - **$time_i$** : the duration between the presentation of the pedagogical resource, of type *test*, to the learner and the response of the learner;
  - **Evaluation-response:** This is a function which attributes a value between 0 and 1 (inclusive) to the learner's response. This evaluation also keeps into account the time of response.

Updating learner profile with interaction traces

- The updating of the learner's profile is done as a function of his/her performances on the pedagogical resources of type *test.*
- The updating process comprises of three steps:
  1. evaluating the learners' response,
  2. to measure the impact of the learner's response on the concepts related with the pedagogical resource in question, then
  3. propagating the updated information in the concept network.

Updating the domain model with interaction traces

- learners with similar competencies should be able to achieve similar results on tests, of similar difficulty, related to a domain concept.
- Otherwise, maybe the domain concept should be taught not as an atomic concept but as a set of sub-concepts.
- For example,



Discovery of new domain concepts

- Let C = $\{c_1 \ldots c_n\}$ be the set of *n* concepts in the domain model.
- Let Q = $\{Q_1 \ldots Q_m\}$ be the set of all pedagogical resources of *test* type like questions, exercises, mcq, problems, etc.
- Q_i is a set of all questions associated with the concept c_i.
- Q_{ij} is the i^{th} question associated with the j^{th} concept (C).
- Let S = $\{s_1 \ldots, s_p\}$ be the set of all students/learners who are using the learning environment to study a particular pedagogical domain.
- Let the set SQ_{ij} = $\{SQ_1 \ldots SQ_q\}$ where SQ_k (k<=p) denote the set of all Students who have attempted Q_{ij}.

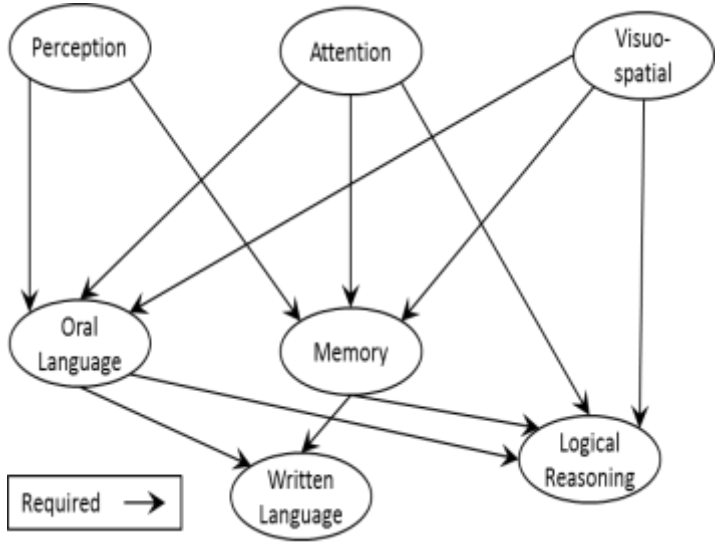
Discovery of new domain concepts (1)

- We will attempt to discover new concepts, related to the concept c_1, based on the responses' evaluation, noted E_{kij}, of each $S_k \in SQ_{ij}$.
- The responses' evaluation is kept in the Trace T_k of each S_k.
- We will analyze the trace base.
- All students who have answered the resource Q_{ij}.
- In the set SQ_{ij}, we will only look at those students who have similar mastery of the concept C_j.
- We classify these students according to their responses to Q_{ij} by using a classification algorithm.
- If more than one class, then there is a strong chance that there are more than one sub-concepts hidden in C_j.
- The results will be presented to the expert for validation.

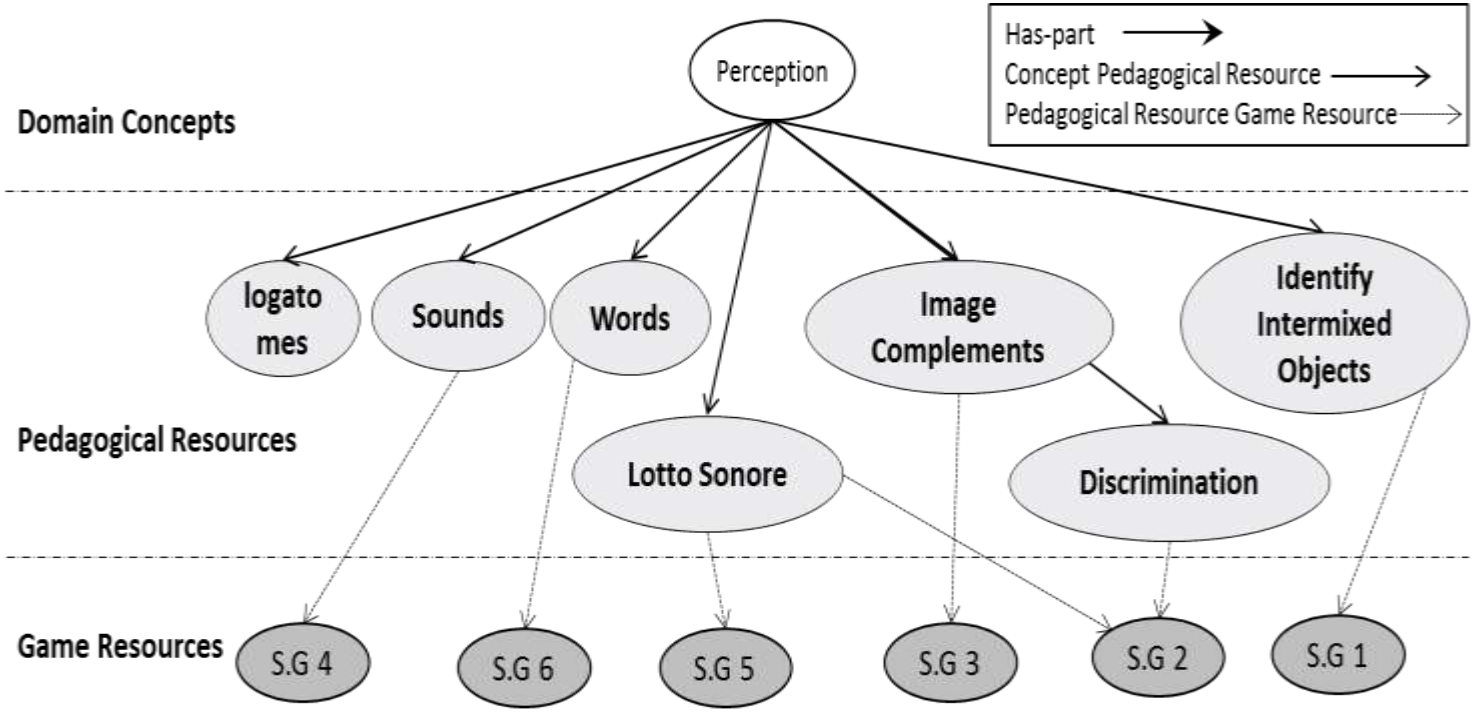
Discovery of new relations between concepts and pedagogical resources

- Learners with the same mastery of a concept will answer to the it's pedagogical resources similarly.
- We compare the competencies of the learners, who have answered the tests correctly, by those who haven't
- This comparison will provide us the **"knowledge gap"** between the two sets of learners.
- If the knowledge gap has concepts related to C_i then we could say that Q_{ij} also requires the competence of the concepts related to C_j in the knowledge gap.

Experiment: Project CLES



CLES Domain Model



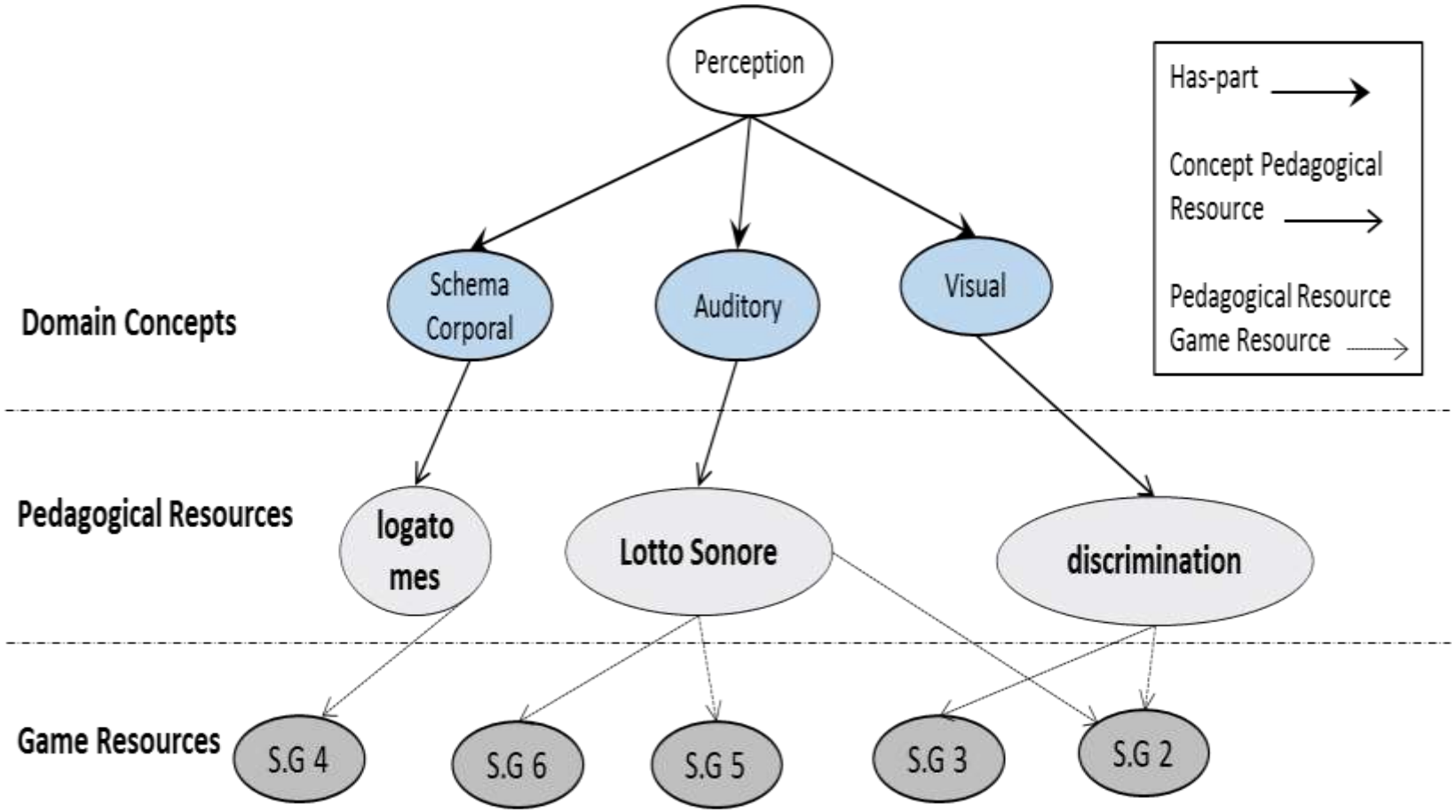
Perception model with pedagogical resources

Experiment: Project CLES (1)

Students	Discrimination	Lotto Sonore	Gnoise – Logatomes
Student 1	0.8	0.25	0.1
Student 2	0.2	0.7	0.2
Student 3	0.85	0.15	0.15
Student 4	0.15	0.7	0.15
Student 5	0.8	0.2	0.2
Student 6	0.75	0.2	0.15
Student 7	0.2	0.9	0.25
Student 8	0.9	0.25	0.3
Student 9	0.25	0.1	09
Student 10	0.1	0.85	0.1
Student 11	0.15	0.3	0.85
Student 12	0.2	0.25	0.8

Test scores of different students

Experiment: Project CLES (2)



The updated model of Perception with the three newly discovered concepts in Blue

Conclusions and Perspectives

- Need to test on a larger data set.
- Need to test with different pedagogical domains and different serious games
- Need of an interface for the expert to easily define rules for knowledge discovery
- Need to integrate different data mining tools to facilitate the knowledge discovery process.