

An Adaptive Tutor to Promote Learner's Skills Acquisition during Procedural Learning

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Workshop “eliciting Adaptive Sequences for Learning”
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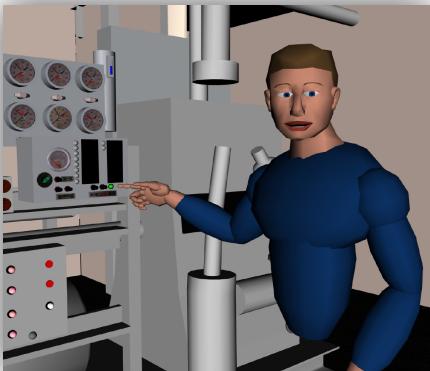
CONTEXT

ECA Positive Effect

Student engagement
[Rowe et al., 2007]

Effectiveness of teaching
[Kokane et al., 2014]

STEVE [Johnson, 1998]



Pedagogical Interaction

Communication content
[Kopp et al., 2008]

Intelligent Virtual Environment
[Aylett and Cavazza, 2001]

Actions and Procedures on Technical Systems

Pedagogical Scenarios
[Saunier et al., 2016]



Windmill Structure and VE Representation



PROPOSITION

LEARNER'S EVOLUTION

Each learner evolves differently

OBJECTIVE

Improving ECA with an adaptive tutor behavior, that is able to adapt the execution of a pedagogical scenario according to the learning performance of a learner

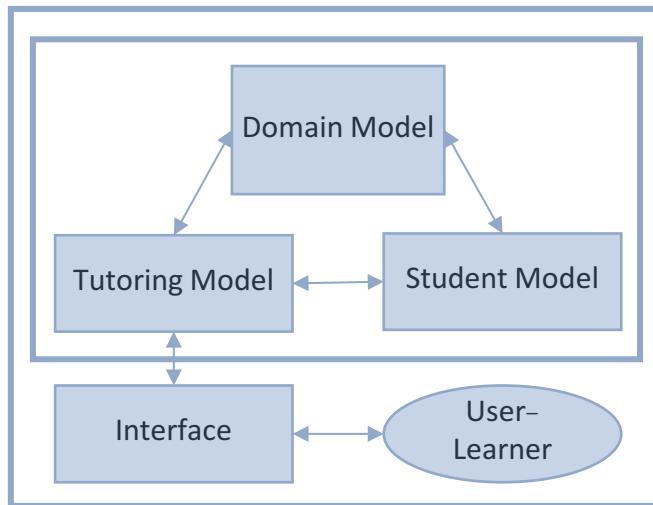
WHY?

To enhance learner's learning performance



INTELLIGENT TUTORING SYSTEM

- Formalization of the intelligent virtual environment



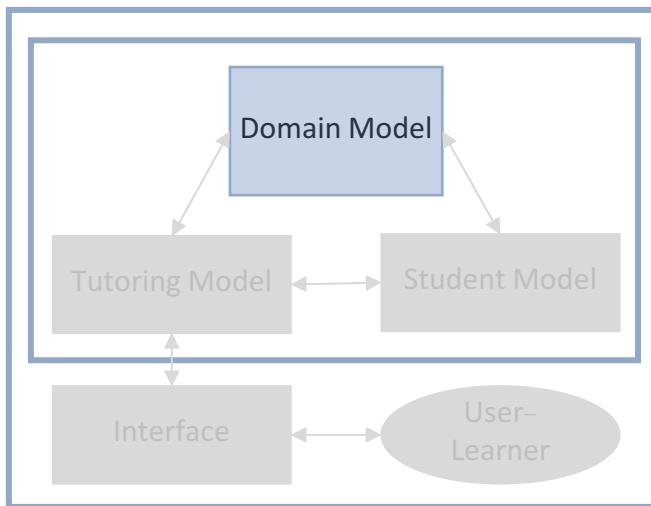
ITS four component architecture

[Nkambou et al., 2010]



INTELLIGENT TUTORING SYSTEM

- Domain expert knowledge



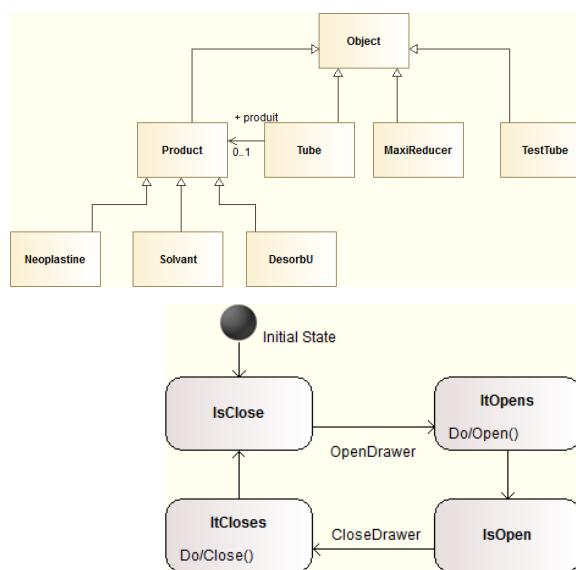
ITS four component architecture

[Nkambou et al. , 2010]



DOMAIN MODEL: MASCARET

- Domain model is represented by MASCARET [Chevaillier et al. , 2001]
 - Virtual Reality meta-model based on UML for designing the semantic of the IVE
 - Domain and **pedagogical** concepts are explicit

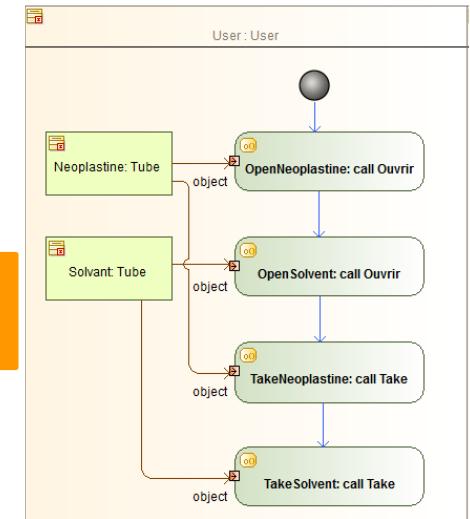


Agent Knowledge Base
(MASCARET)



Users & Agents
activities and
interaction

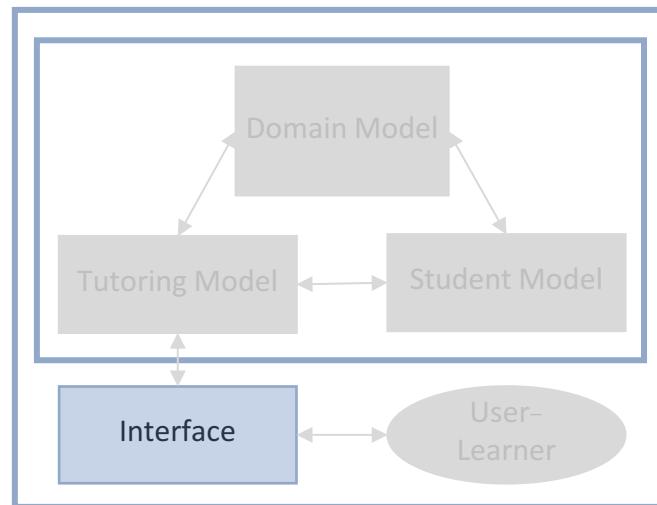
Entities'
Behavior





INTELLIGENT TUTORING SYSTEM

- Natural realization of pedagogical actions



Embodied
Conversational
Agent (ECA)

ITS four component architecture

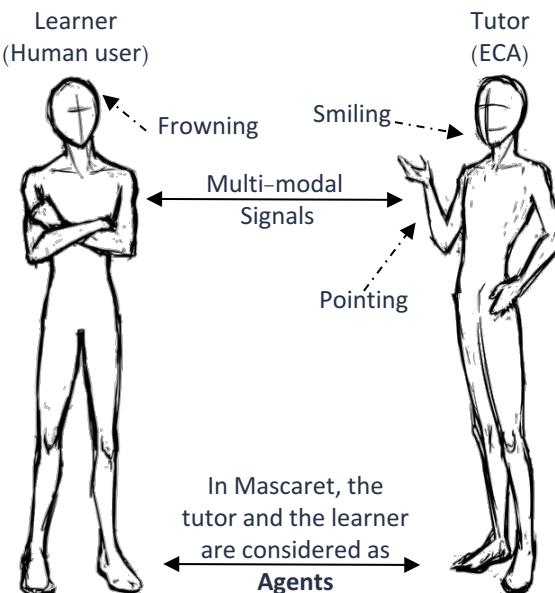
[Nkambou et al. , 2010]



IINTERFACE

■ Interface is represented by ECA SAIBA Compliant

PRIMITIVE ACTIONS
Verbal communication: giving an information, ...
Non-verbal communication: multimodal signals, ...
Actions on the environment: manipulating an object, ...
Navigation: observing, moving, ...
PEDAGOGICAL ACTIONS
On the virtual environment: highlighting an object, ...
On the user's interaction: changing viewpoint, ...
On the structure of the system: describing the structure, ...



GRETA
[Niewiadomski et al., 2009]



VHT
[Gratch et al., 2013]



MARC
[Courgeon, 2011]



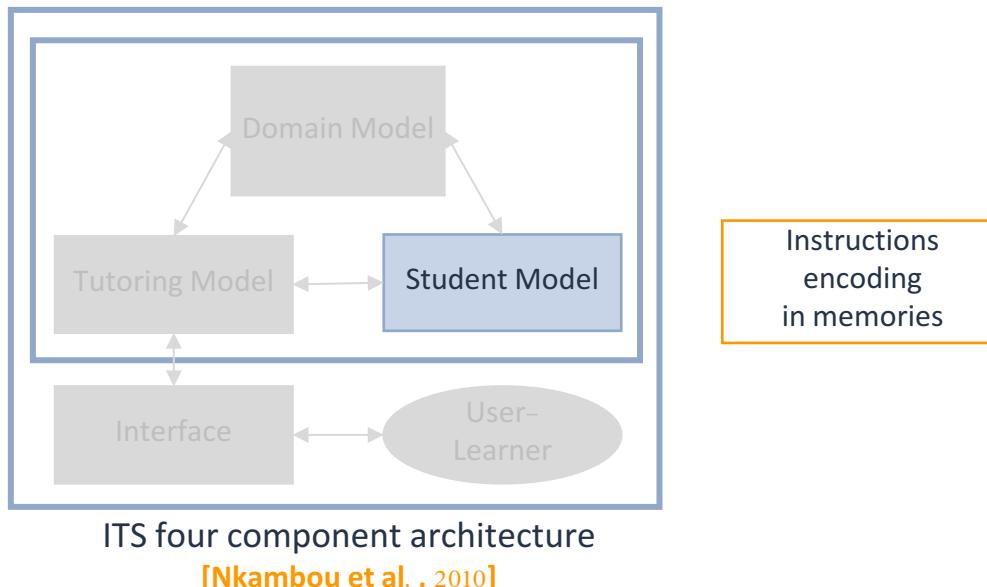
INTERFACE





INTELLIGENT TUTORING SYSTEM

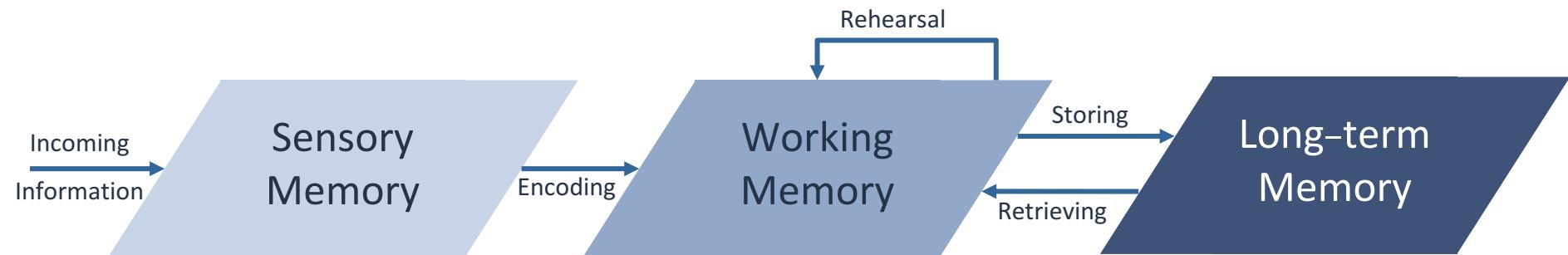
- Adaptation of the pedagogical scenario based on the learner's knowledge





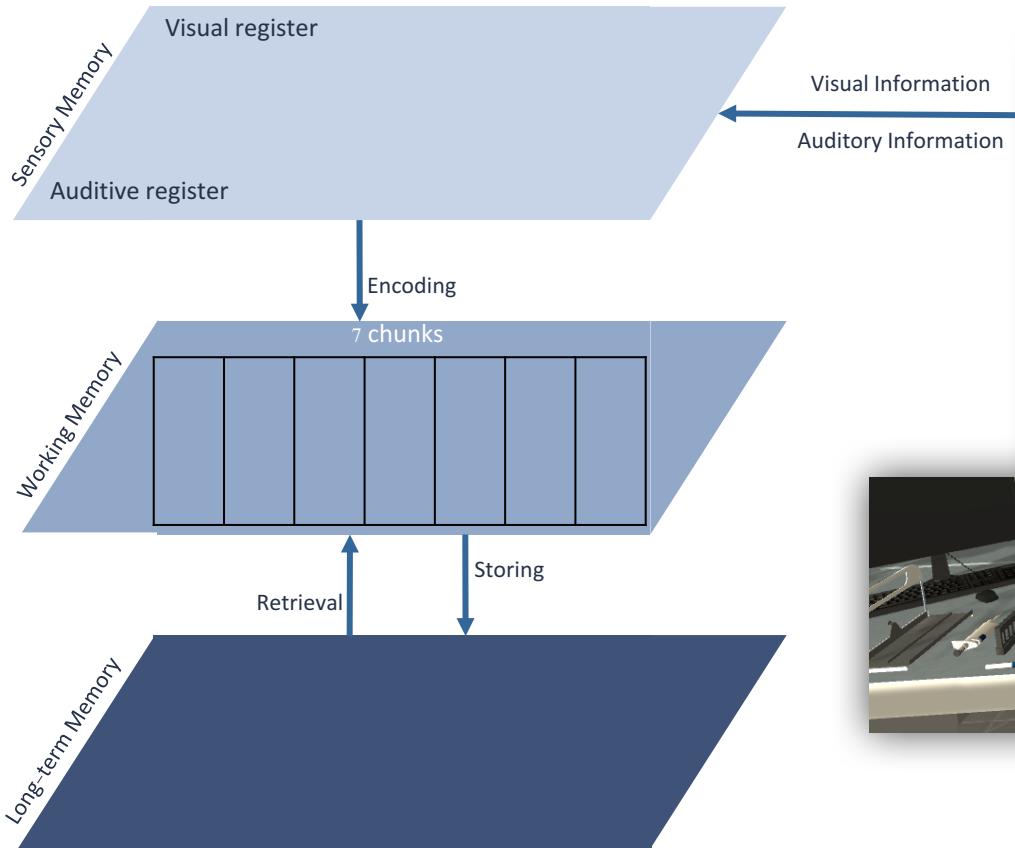
STUDENT MODEL

- General theoretical framework of human memory [Atkinson and Shiffrin, 1968]

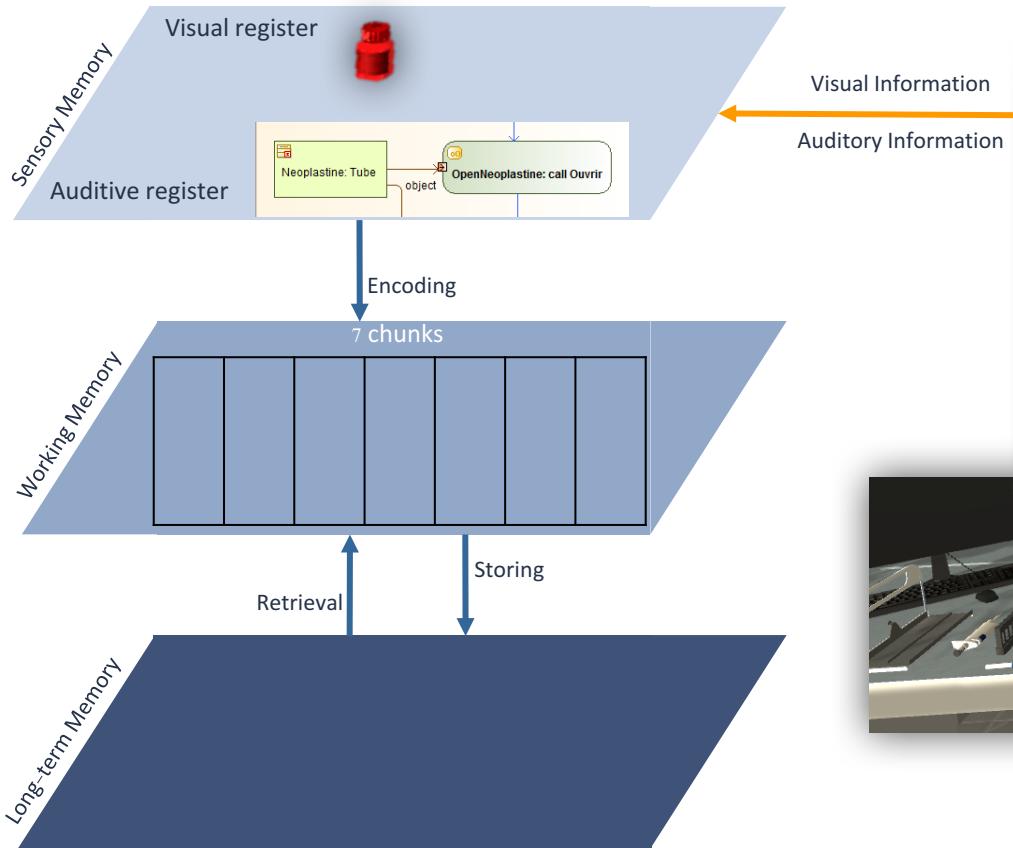


- Main contribution:
 - Formalizing the content of memory
 - Implementing the execution flow of memories

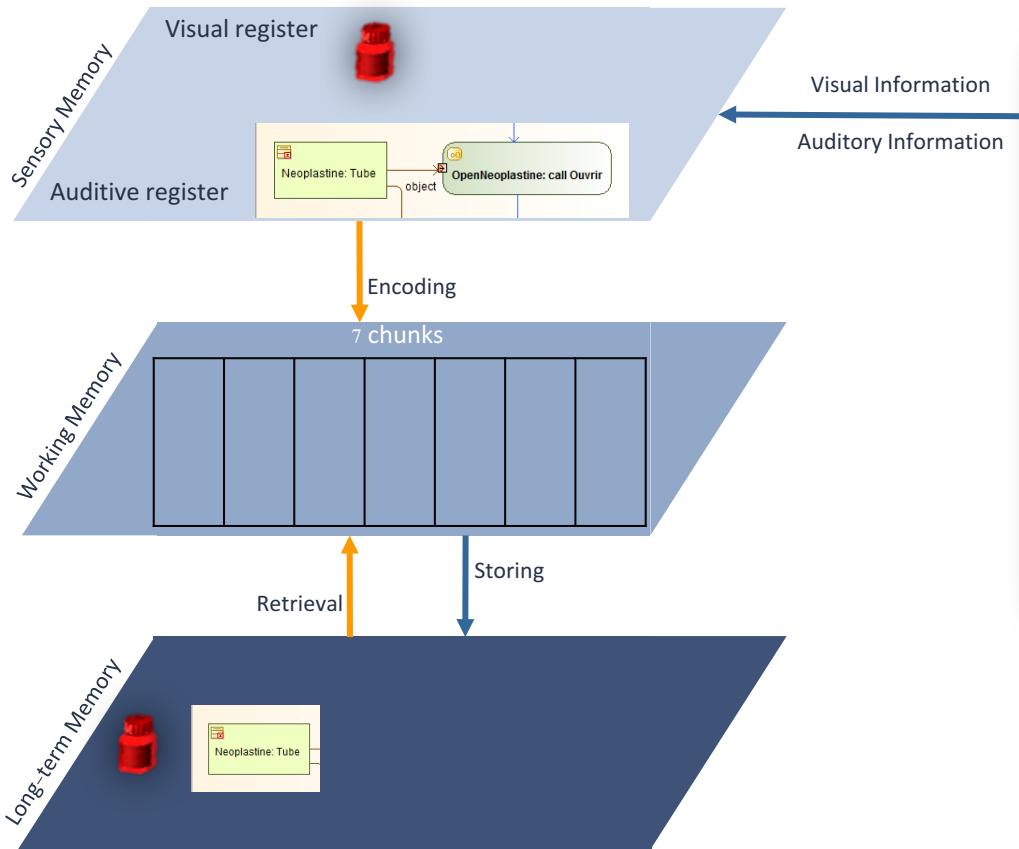
Example



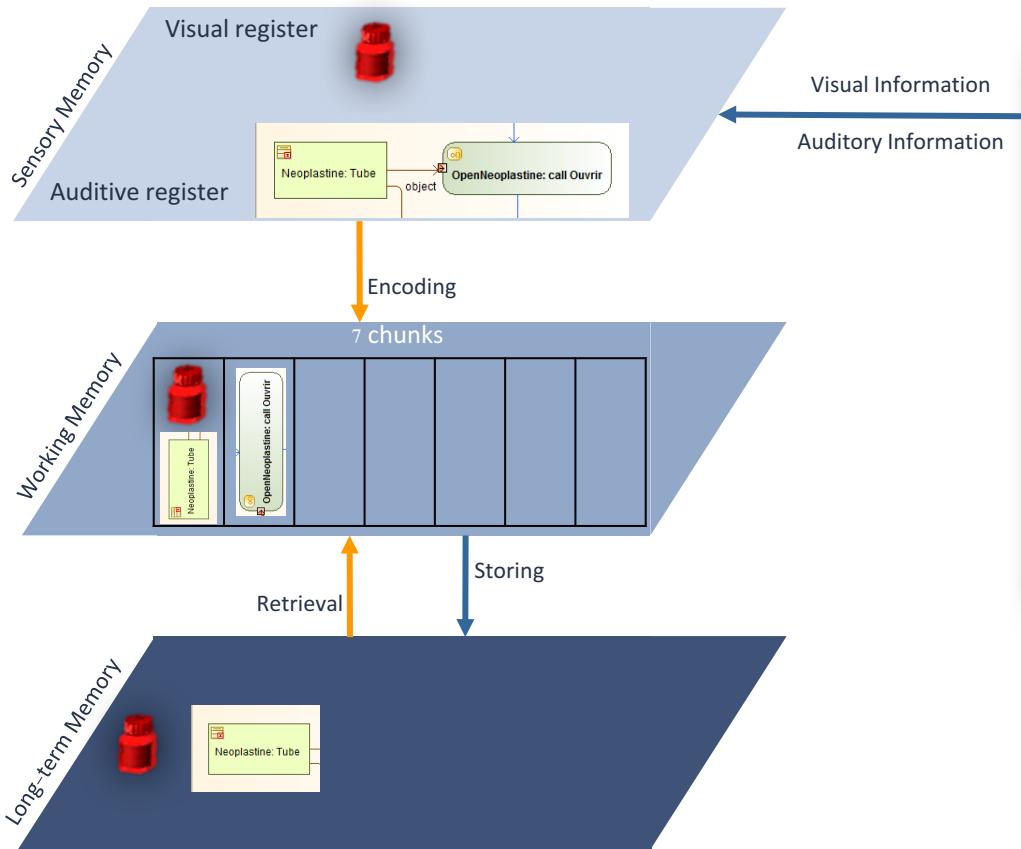
Example



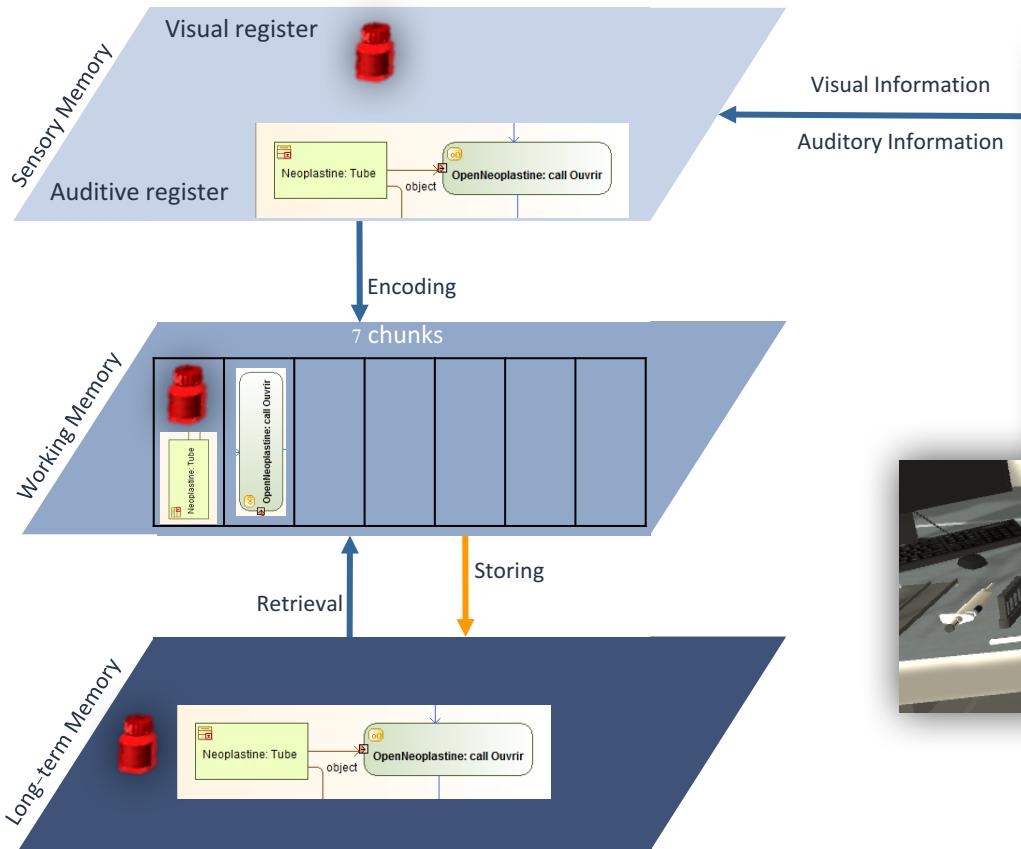
Example



Example



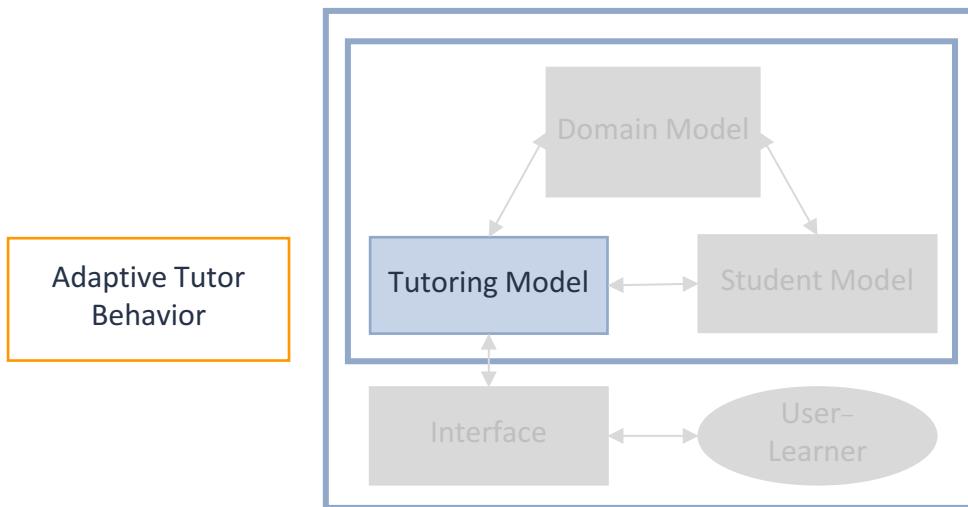
Example





INTELLIGENT TUTORING SYSTEM

- Adaptive tutor behavior based on Domain and Student Model

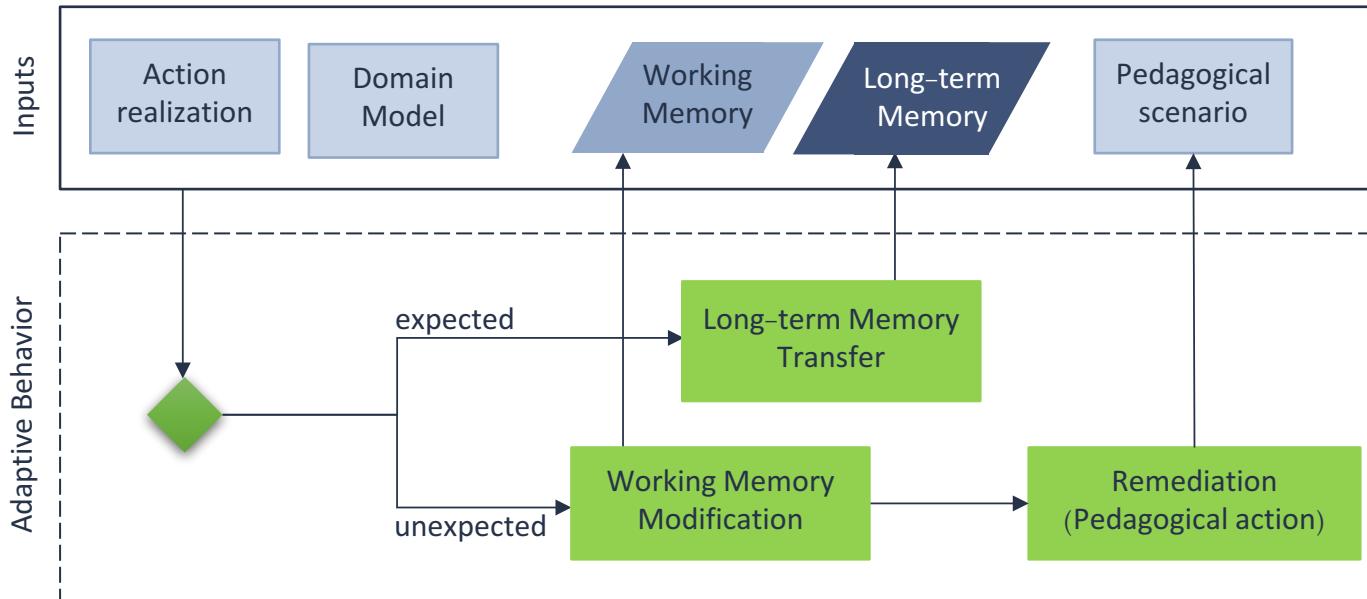


ITS four component architecture

[Nkambou et al. , 2010]



TUTOR BEHAVIOR



Based on cognitive psychology hypothesis.

Behavior to be defined using UML activity diagrams.



TUTOR BEHAVIOR



EVALUATION

Objective

Evaluate the impact of our adaptive virtual tutor on the learner's learning performance

Application

Procedural learning for blood analysis in a virtual environment laboratory

Participants

Two groups of 22 participants each, 14% female, mean age 22,7

Objective Performance Measure

Time, errors and Help request

Experimental Protocol

Same first trial for both groups
“Systematic Assistance”

Group I

Non-Adaptive Tutor

No pedagogical actions

One type of help request

Feedback when incorrect action
(Goal + Action + Object)

Group II

Adaptive Tutor

Pedagogical actions based on the learner's memories content

Different types of help request

Feedback when incorrect object and/or action and inaction



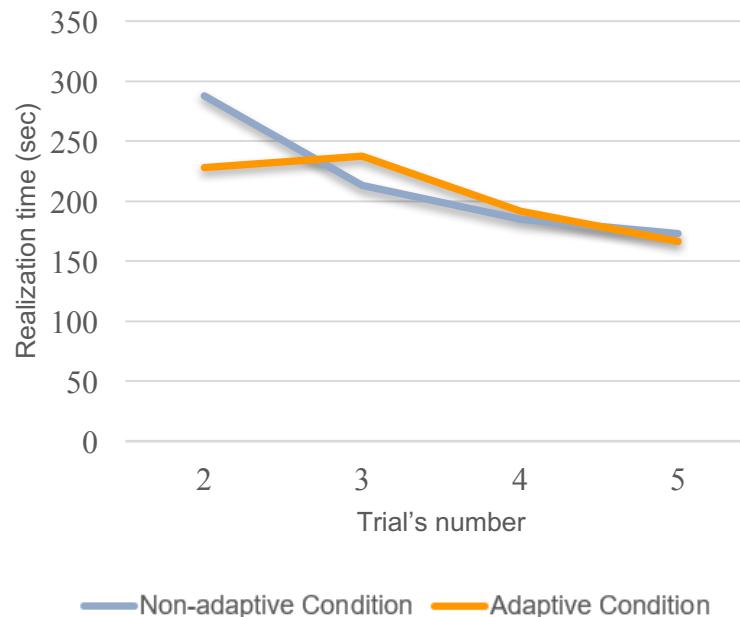
RESULTS

Statistical analysis applied starting trial 2

MEAN OF REALIZATION TIME

Significant results only
for the second trial:

*Learner's in adaptive
condition takes less time to
realize the procedure*





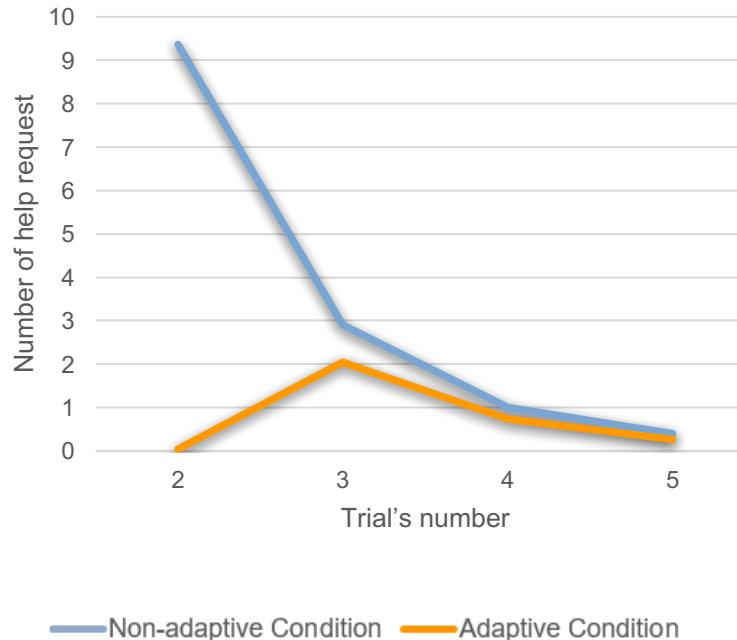
RESULTS

Statistical analysis applied starting trial 2

MEAN OF HELP REQUEST

Significant results for the second trial and for all trials:

In general, adaptive condition participants require less help





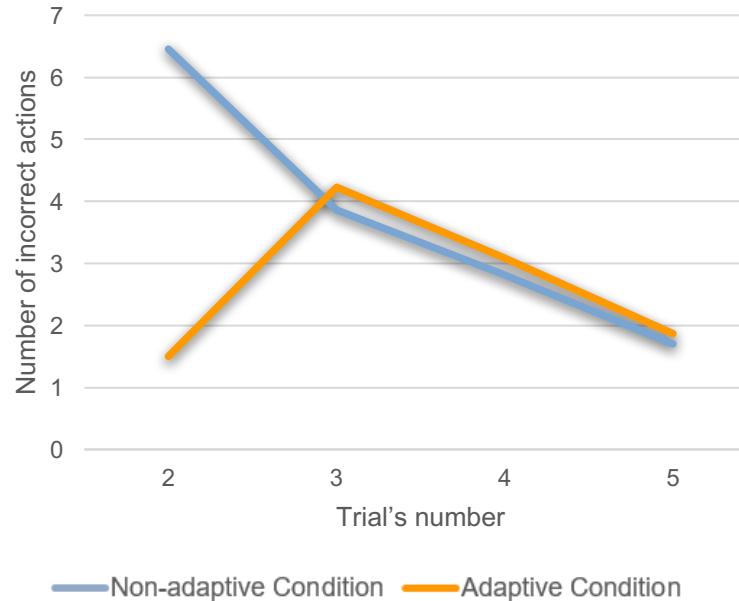
RESULTS

Statistical analysis applied starting trial 2

MEAN OF INCORRECT ACTIONS

Significant results for the second trial and for all trials:

In general, adaptive condition participants make fewer incorrect actions.



DISCUSSION

“ Generally, interaction with an adaptive virtual tutor improves learner’s performance

Specially, during the first executions of the procedure



CONCLUSION AND PERSPECTIVES

We propose an adaptive virtual tutor based on Intelligent Tutoring Systems and Cognitive Psychology (Theory of Human Memory).

The proposed model can also be applied in use cases of cognitive impairments, Alzheimer disease: modification of the memory flow.



THANK YOU!



Any questions?

You can contact me at
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