

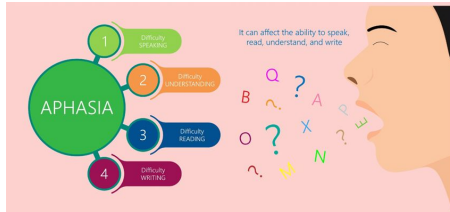
Cognitive Aspects of Avatars - Case Studies

Arantza del Pozo
Vicomtech

adelpozo@vicomtech.org

LUMINOUS Pilots

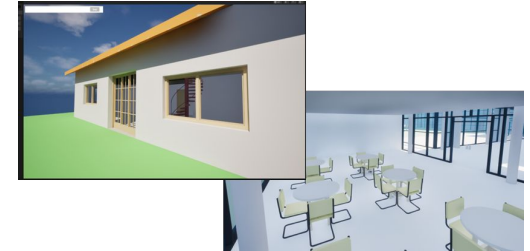
Personalized Neurorehabilitation



Health, Safety and Environment Training

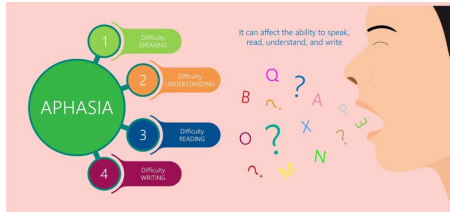


Architectural Design Review



LUMINOUS Pilots

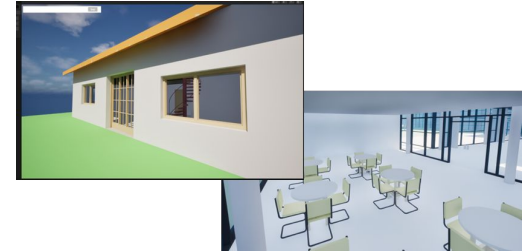
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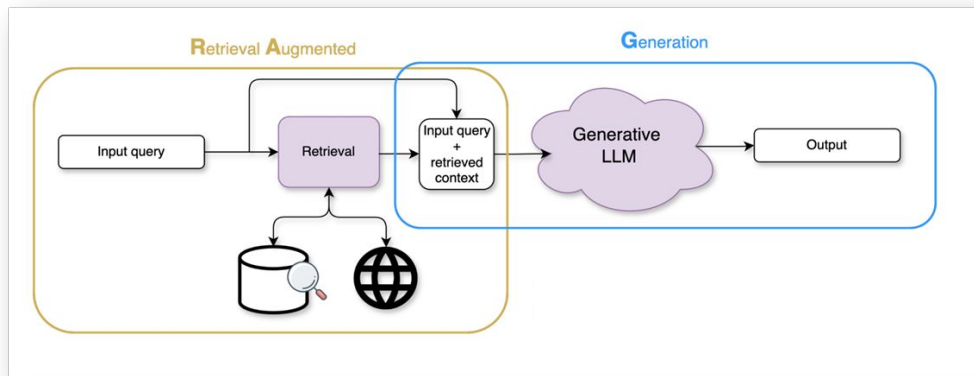


Metacognition Chatbot - problem

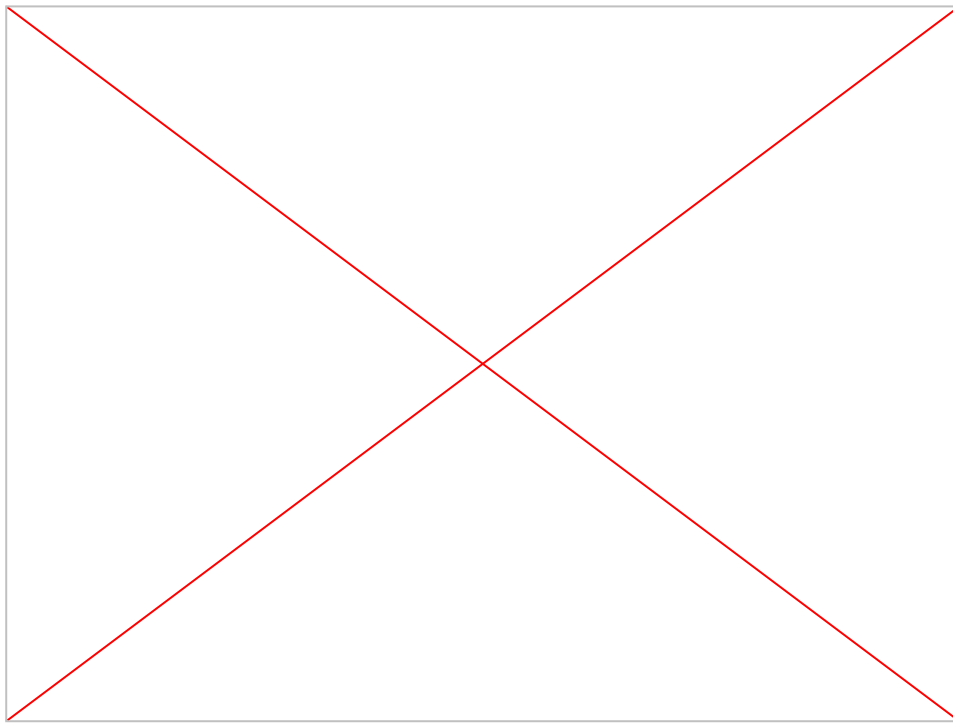
- Neurorehabilitation guidelines recommend applying **metacognition strategy training** to facilitate enhanced recovery and promote generalization to daily functioning
- Currently, metacognition is typically delivered through **therapist guided task specific interventions**
- Would it be feasible to administer **personalized metacognitive strategy training** linked to a **digital therapeutics program**?

Metacognition Chatbot - technical approach

- Development of a **virtual assistant, expert on metacognition and psychoeducation**.
- **Knowledge sources** have been compiled, together with relevant question-answer **test sets** for evaluation.
- A **Retrieval Augmented Generation (RAG) prototype** has been implemented on the compiled knowledge base.



Metacognition Chatbot - demo

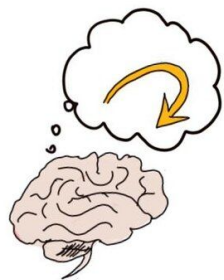
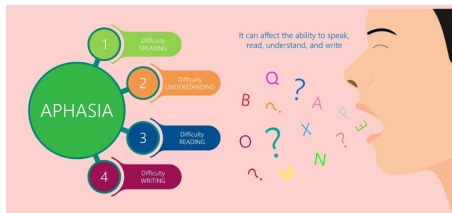


Metacognition Chatbot - next steps

- Working on practical **approaches** to **provide** the Metacognition Chatbot with **trustworthy general knowledge** beyond the metacognition-specific knowledge sources
- **Testing** with **real patients**

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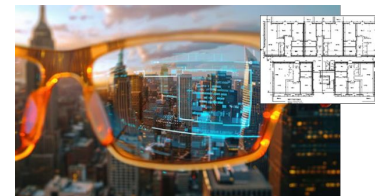
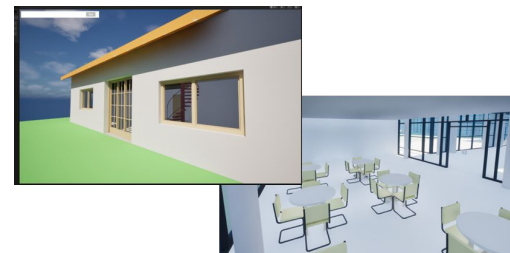
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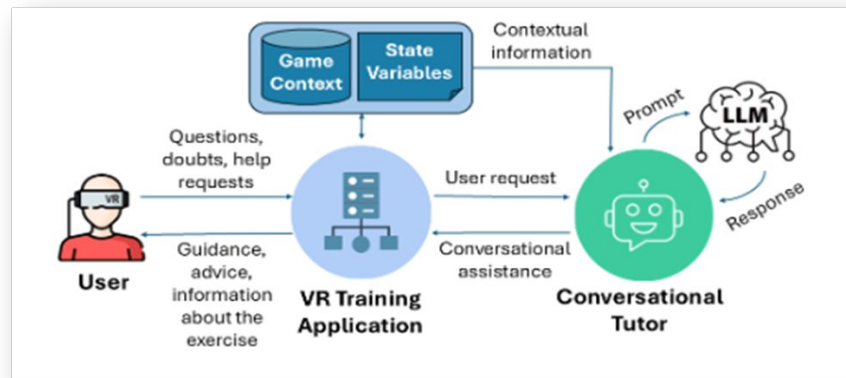


Fire Extinguisher Assistant - problem

- Current support/assistance/guidance to the user during HSE Training:
 - Based on **static hints**
 - **Limited help**: it only repeats the hint for the current step
 - **Basic interaction**: a repeat button

Fire Extinguisher Assistant - technical approach

- First use of **LLMs as virtual tutors** in emergency response for VR training
- Address interaction gaps with **dynamic, context-aware communication**
- Integrate **game context** and **state variables** to enhance LLM response accuracy and relevance, achieving significant quality improvements



Fire Extinguisher Assistant - technical approach

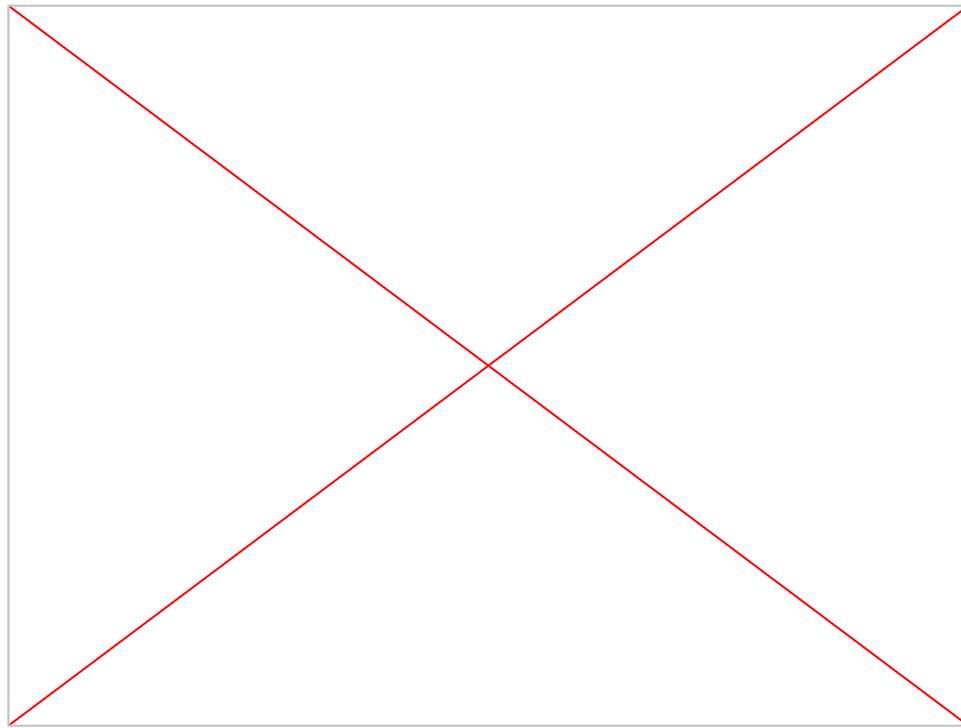
	BLEU	ROUGE-L F1	BERTScore R	BLEURT	G-Eval
<i>Zero Shot</i>					
Vanilla	0.35 ± 0.07	9.58 ± 0.26	61.38 ± 0.27	48.18 ± 0.27	14.05 ± 0.79
GC	0.74 ± 0.10	11.90 ± 0.26	64.09 ± 0.61	48.78 ± 0.42	38.99 ± 1.55
GC + SV	0.70 ± 0.09	14.64 ± 1.04	65.51 ± 0.58	50.52 ± 0.43	39.43 ± 1.82
<i>Few Shot</i>					
Vanilla	0.61 ± 0.14	12.64 ± 0.64	63.76 ± 1.25	47.38 ± 1.02	32.22 ± 2.90
GC	1.20 ± 0.29	13.76 ± 0.55	65.25 ± 0.84	48.84 ± 1.12	33.69 ± 2.16
GC + SV	1.19 ± 0.11	16.71 ± 1.42	66.77 ± 0.88	50.72 ± 0.73	43.83 ± 2.45

Table 1: Performance (Mean ± StdDev) of Llama-3.3-70B across Zero- and Few-Shot settings for the different prompt configurations. In bold, highest values per metric (including StdDev).

Prompt	Correct	Partially Correct	Incorrect
<i>Zero Shot</i>			
Vanilla	7.2%	9%	83.8%
GC	28.1%	12%	59.9%
GC + SV	33.1%	14.4%	52.5%
<i>Few Shot</i>			
Vanilla	15.3%	13.6%	71.1%
GC	28.2%	16.2%	55.6%
GC + SV	33.2%	16.2%	50.6%

Table 2: Human Evaluation results of Llama-3.3-70B across prompt configurations.

Fire Extinguisher Assistant - demo

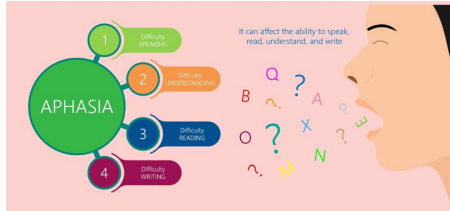


Fire Extinguisher Assistant - next steps

- Exploring ways to **better model VR game variables** and applying **reasoning techniques** to help LLMs better generalize over them
- Applying **data augmentation** techniques on the compiled datasets and exploiting the implemented system to generate sufficient training data to explore and compare the performance of **fine-tuning** approaches
- **Testing with real users**

LUMINOUS Pilots

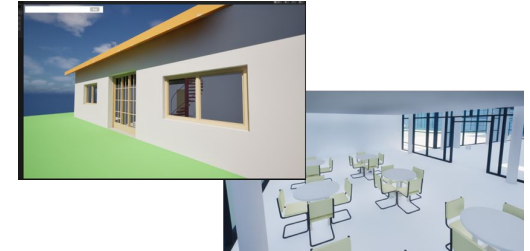
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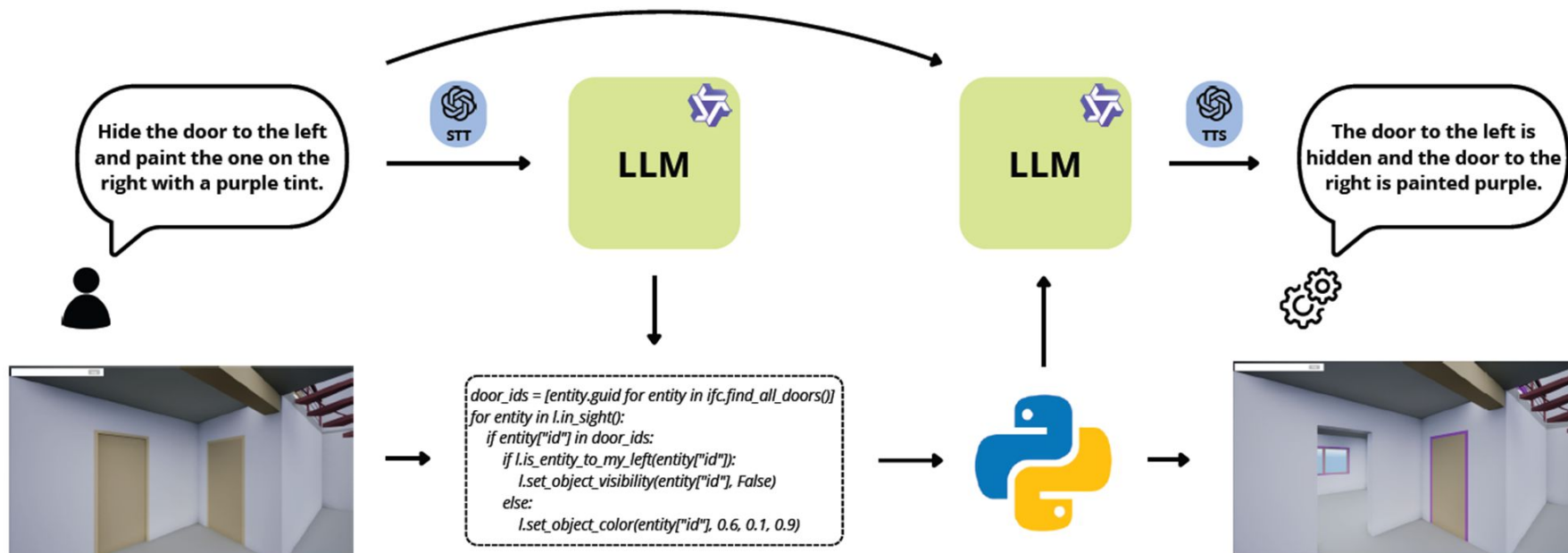


Architectural Design Review - problem

- Architectural design relies on 3D modeling procedures using Building Information Modeling (BIM) formats.
- BIM changes need to be **implemented manually**, lengthening the design process and making it difficult quick prototyping.

Architectural Design Review - technical approach

- Incorporating an LLM assistant able to answer queries and make changes directly in the VR scenario.



Architectural Design Review - technical approach

The prompt incorporates richer contextual information for correct coding:

- **Task definition:** Specifies what information is available and the output format.
- **API documentation:** Defines the available Python functions and classes.
- **Initial State of the BIM:** The initial configuration of the environment.
- **Few-shot examples:** A set of seven query-code pair examples.
- **User query:** The specific input provided by the user.

Architectural Design Review - technical approach

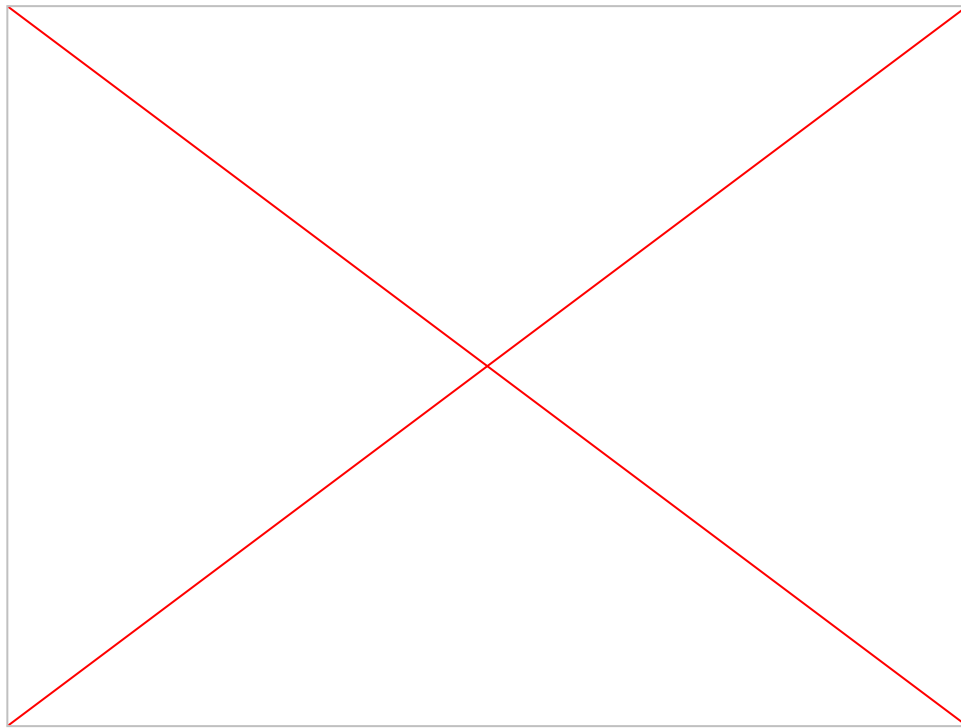
Model	Error Type ↓		Accuracy ↑
	Runtime	Semantic	
Qwen2.5-1.5B	40.0	43.3	17.7
Qwen2.5-7B	26.7	49.6	23.7
Qwen2.5-32B	20.0	44.3	35.7
Qwen2.5-72B	11.7	50.6	37.7

Table 1: Percentage of instances that were correctly completed. Incorrect instances are separated between the ones that failed to finish the execution (runtime) and the ones with incorrect outcomes (semantic).

Model	Error Type ↓			
	No Change	Incorrect	Collateral	Other
Qwen2.5-1.5B	53.3	14.3	5.7	9.0
Qwen2.5-7B	45.7	24.7	2.3	4.3
Qwen2.5-32B	29.7	27.0	2.3	5.3
Qwen2.5-72B	21.0	35.7	1.0	4.3

Table 2: Distribution of type of errors made by each model due to either runtime or semantic errors. Percentages are computed considering all instances to maintain consistency across models.

Architectural Design Review - demo



Architectural Design Review - next steps

- We plan to define a system that uses **different submodules** that focus on either **interacting** with the building or **retrieving information**, depending on the user's query.
- **Testing** with **real users**
- **Porting** of the system core to an **AR headset**

Questions?