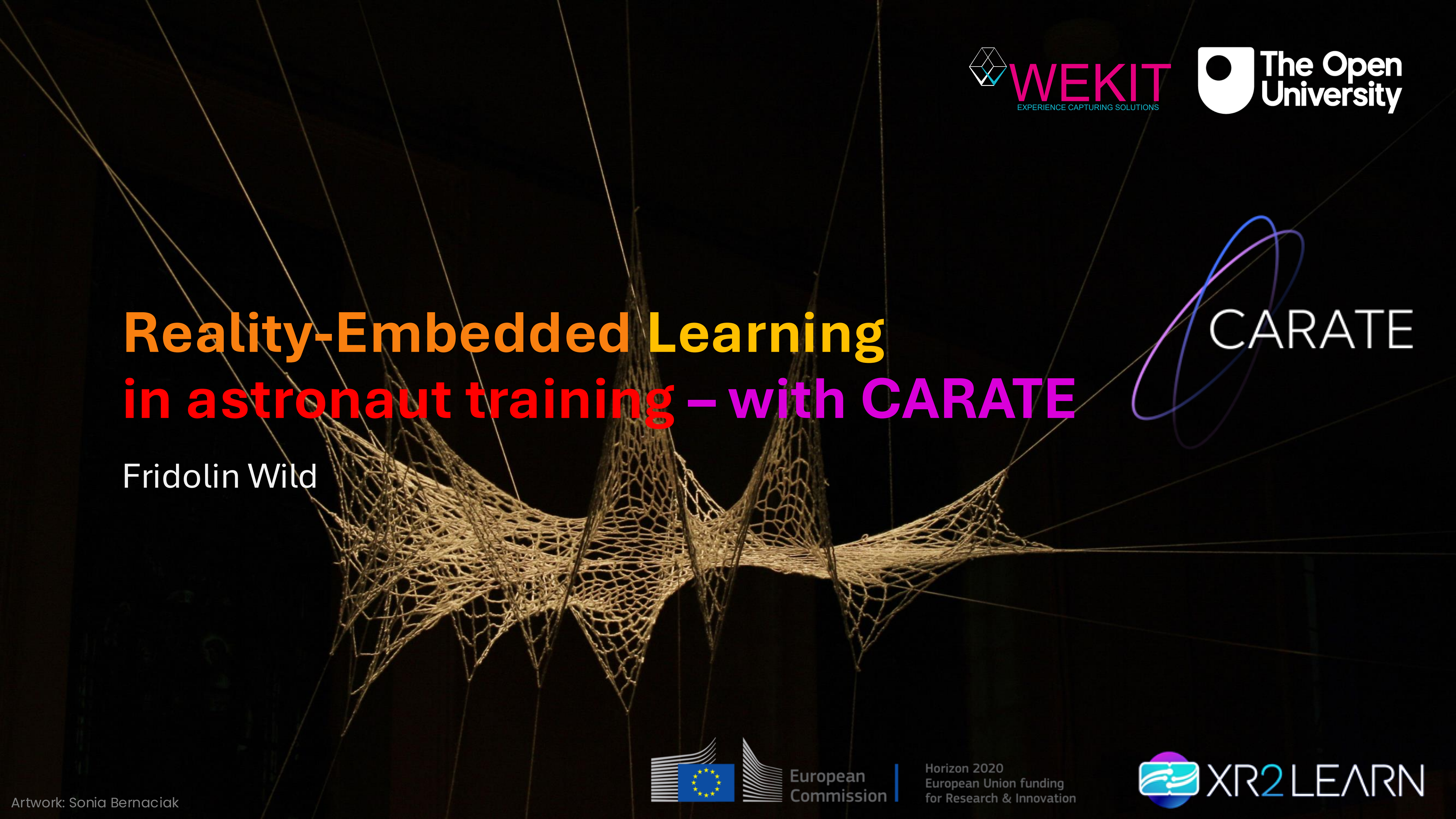
WEKIT
EXPERIENCE CAPTURING SOLUTIONS

The Open University

CARATE

Reality-Embedded Learning in astronaut training – with CARATE

Fridolin Wild



Artwork: Sonia Bernaciak

European Commission
Horizon 2020
European Union funding
for Research & Innovation

XR2LEARN

PLAN

My Lab

The Big Picture

Embedded Learning

(Some) Achievements

The Open University

Performance Augmentation seeks to bridge the dissociative gap between abstract knowledge and its practical application, researching radically new methods to connect knowing something ‘in principle’ to applying that knowledge ‘in practice’.

PAL

Inception in **The Bazaar.**

Prototyping in **The Lab.**

Validation in **Innovation Pilots.**

EdTech Ignite

CARATE

WEKIT
EXPERIENCE CAPTURING SOLUTIONS

CARATE Management Team

DR STEPHAN PASCAL

CEO

27+ years in the European Commission at senior level (Head of Unit, Advisor). Former British Telecom. Extensive financial and management experience in leading skilled professional teams in achieving complex and challenging objectives with concrete results.

PROF FRIDOLIN WILD

CTO

Full professor at The Open University, director of an XR R&D lab, co-lead of the OpenXR Studios for production of XR experiences. Excellent track record in teaching and research of XR. Technical brain of WEKIT ECS and lead of the developer community.

DR MIKHAIL FOMINYKH

CIO

Researcher at the Norwegian University of Science and Technology, coordinating of XR/3D R&D in the Immersive Tech for Learning lab of NTNU. Coordination of 10+ large-scale international projects. Director of Enterprise Solutions.

DR ENDRIT KROMIDHA

CCO

Associate Professor in Entrepreneurship and Innovation at University of Birmingham. VP for Policy and Practice at the Institute for Small Business and Entrepreneurship. Certified project manager. Business development and investment strategy.

DR CARLO VIZZI

CLO

Astronaut instructor at the ESA European Astronaut Centre (EAC), with a background in Computer Science. Started at Thales Alenia Space Italy and later ALTEC. Established XR laboratory at ALTEC. Oversees experiments on ISS & develops XR tools to enhance astronaut work.

+ 17 developers, designers, 3D specialists, learning designers, business developers, …

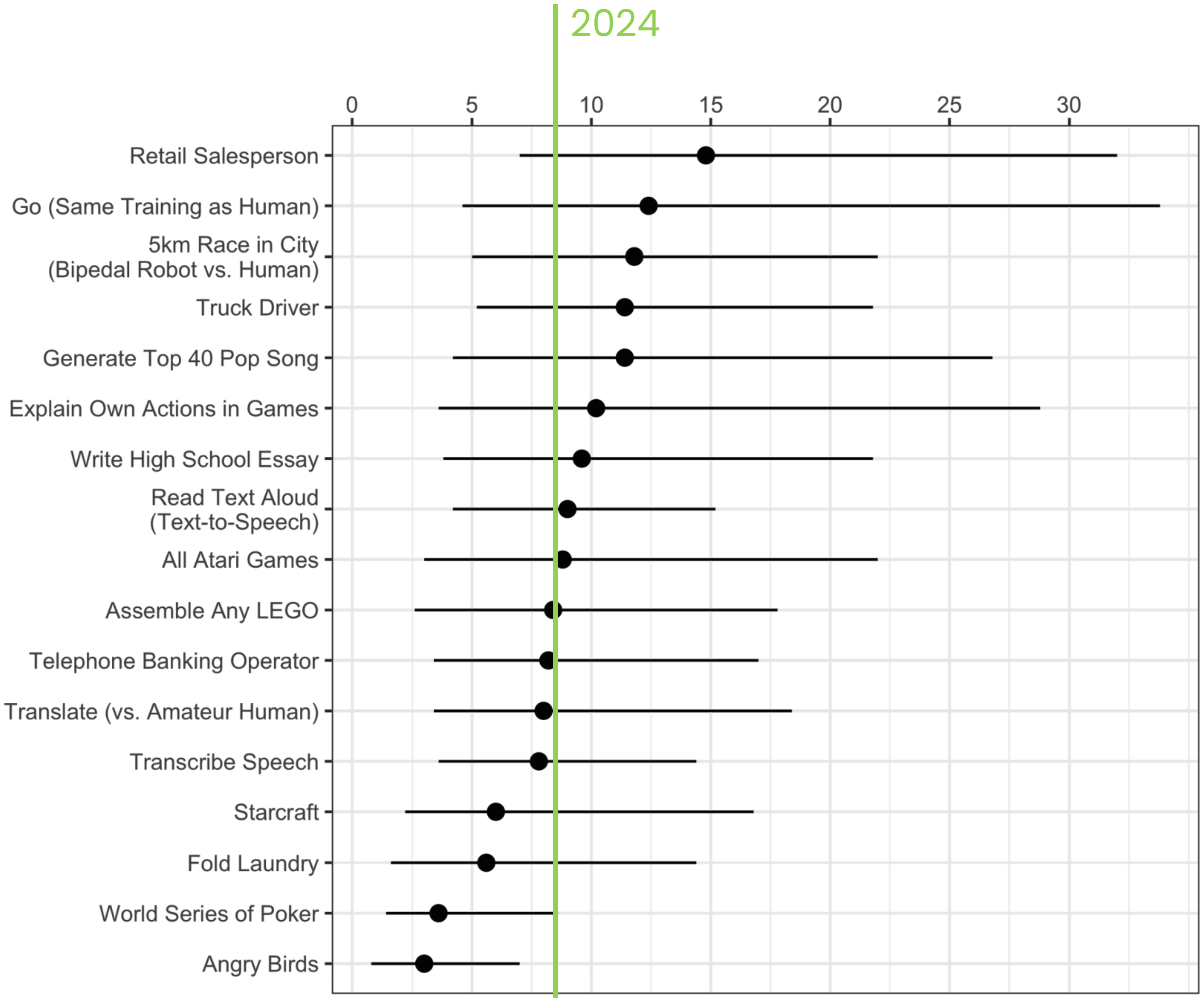
"Almost **40 percent** of global employment is exposed to AI"

"Model simulations suggest that, with high complementarity, higher-wage earners can expect a more-than-proportional increase in their labor income, leading to an increase in labor income inequality."

– IMF, 2024

Grace, Salvatier, Dafoe, Zhang, Evans (2017)

When will AI exceed human performance?



73% of organisations are currently facing skills shortages. This rises to **86%** of large organisations.

42% of organisations say they have been prevented from filling roles due to lack of applicants.

72% of organisations say skills shortages have increased workload on existing staff.

78% of large organisations have implemented a plan relating to recruitment, their workforce or their wider impact. This compares to only **45%** of micro firms with fewer than 10 employees.

54% of organisations say they don't have initiatives, skills programmes, or adjustments for specific talent pools, including underrepresented groups. This rises to **65%** of micro organisations.

31% of organisations have seen a net change in the number of employees over the age of 50 in the last three years.

British Chambers of Commerce

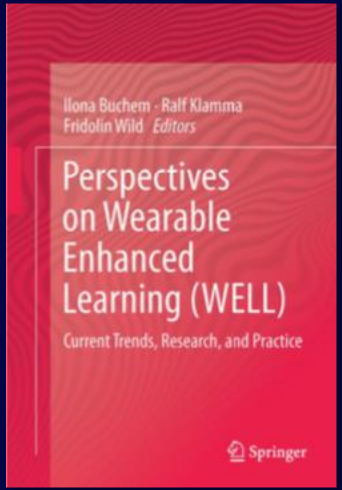
The Open University

Business Barometer

June 2023

The Open University

Ages of Learning Technology



	EDTECH 1.0	EDTECH 2.0	EDTECH 3.0	EDTECH 4.0
innovation:	**DIGITIZED**	**MANAGED**	**INDIVIDUALIZED**	**EMBEDDED**
technology:	email, file transfer	web	web, apps, ebooks	XR, AR, VR, MR
standards:	MIME, FTP, HTTP	SCORM, LOM, DC	LD, WIDGETS, CC/LTI	ARLEM, XAPI
devices:	terminal, pool PC	PC, laptop	mobile, tablet	glasses, mobile, e-textile
systems:	mail/ftp client, browser	LMS	PLE, LA, apps	Spaces, Metaverse

Mobile
Computing

Wearable
Computing

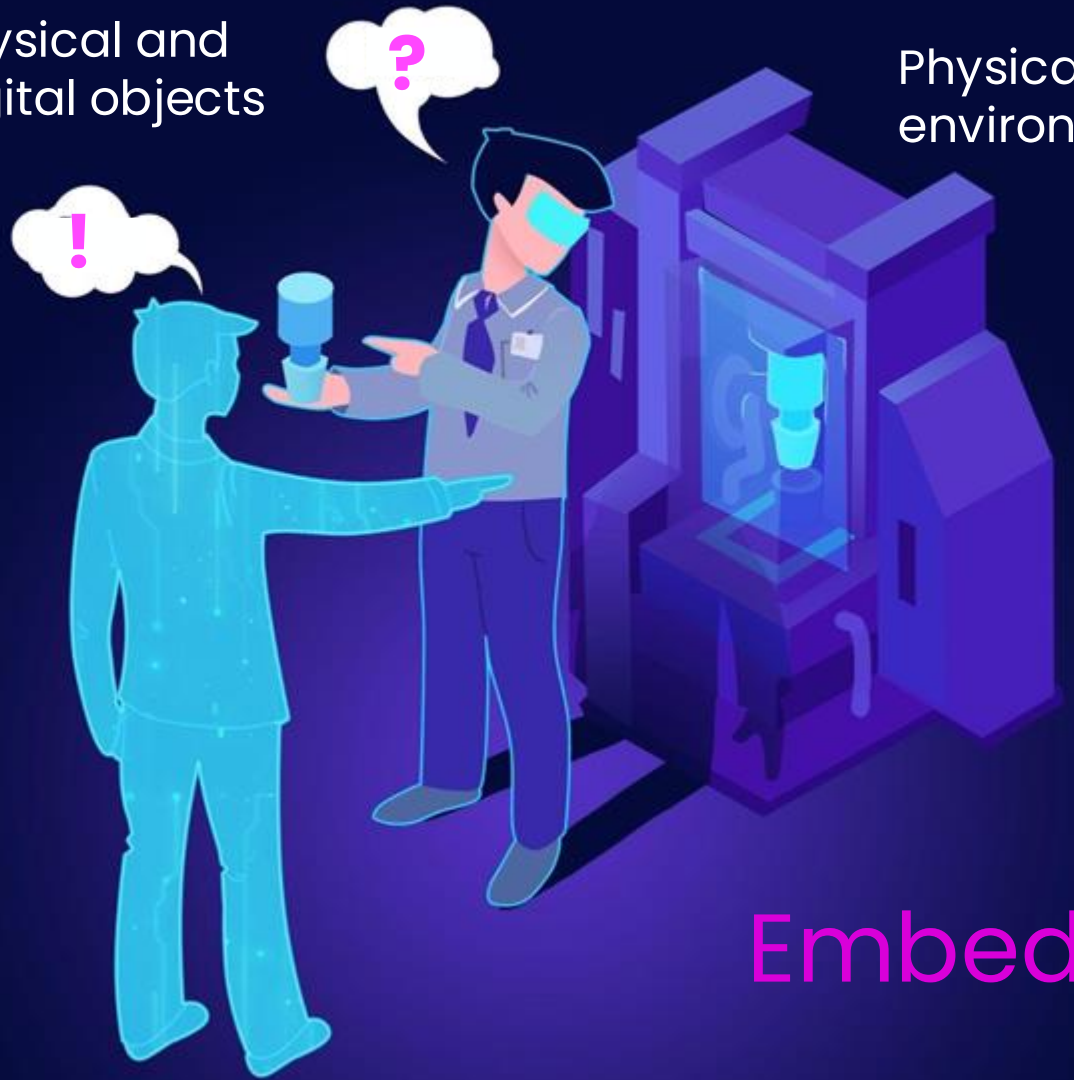
Physical and
digital objects

Physical
environment

Hologram
Digital Twin

AI Instructors

Remote Peers
and MKO



Embedded Learning

Premise of embedded learning

<p>{}

Competence:
potential for action

purposive?

{:}

deliberate practice

Information is a **logical abstractor**.

But: mnemonic form cues recall

Experience determines level of performance

= dissociative gap between knowledge and its practical application

deep learning requires ‘disintermediation’

Actively (co-)design memorable experience

Facilitate self-determination

Support serendipity and exploratory discovery

Embedded vs traditional learning

- Cued recall
- Context
- Multiple perspectives
- Multiple representations
- Memory palace
- Spatial cognition, participation oriented
- Learning by experience, learning by doing
- Embedded in practice

- Model based
- Explicit
- Comprehensive and absolute
- Single best representation
- Frame of reference
- Multimedia, communication oriented
- Learning by conversation, multimedia learning
- Dedicated learning space

- More flexibility and autonomy needed
- Real-time support for joint crew training and joint authoring is needed
- Enterprise-grade ‘embedded learning’ analytics needed (for predictive capability development)

- Space is a pretty **extreme environment**
- Astronaut training of globally dispersed teams in classic mode takes **too long**
- Ground support from Earth **not available** or only available at specific timeframes

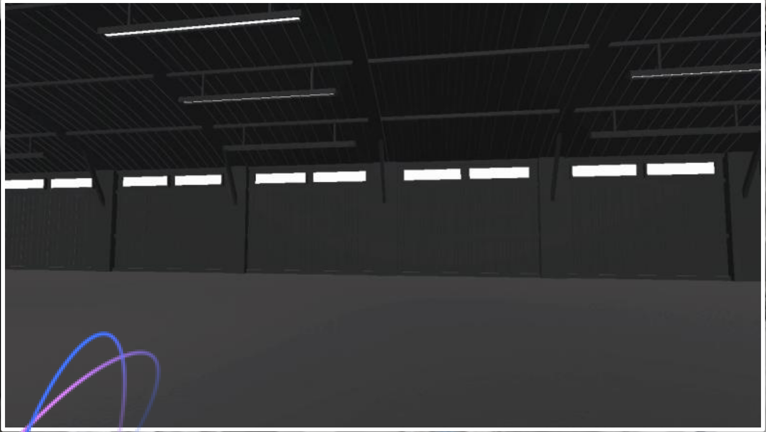
CARATE

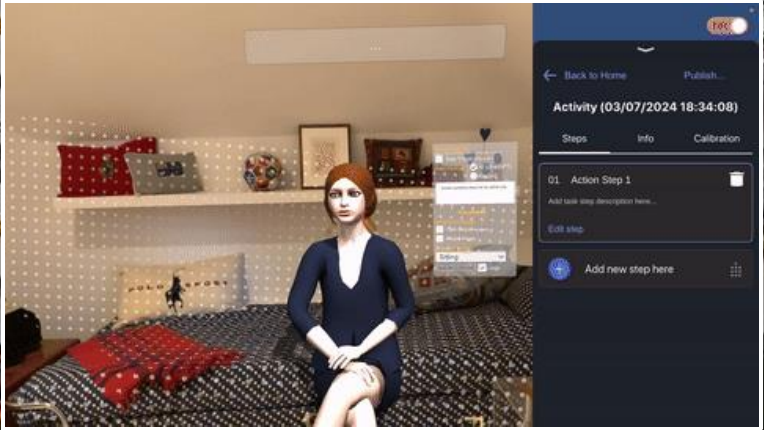
Highlights

1. **Collaborative XR-enhanced authoring:**
   Development of procedure and training materials in a collaborative environment (Metaverse)

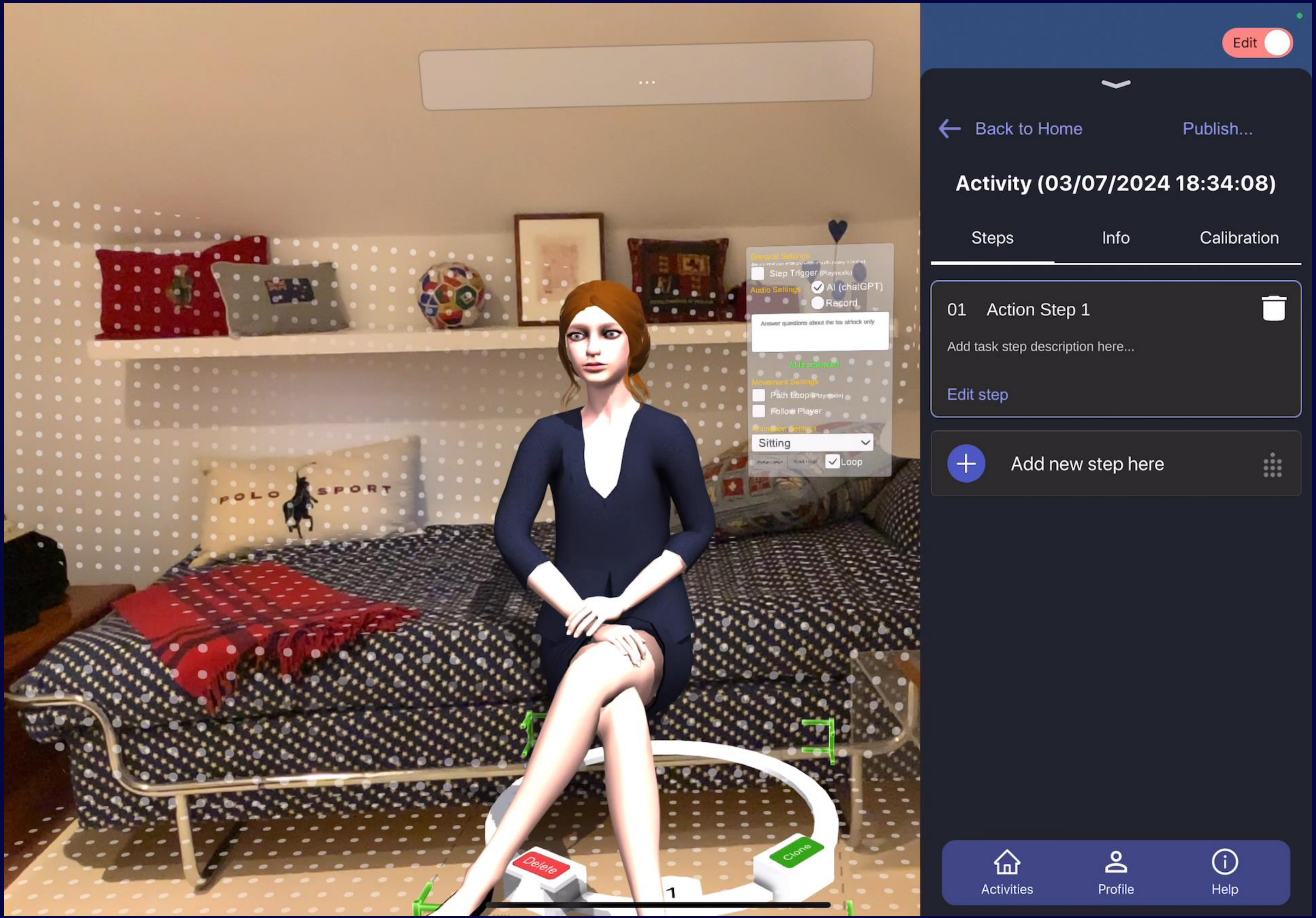
2. **XR-enhanced live instructor support:**
   Crew training with real time support by instructor

3. **Demi-synchronous, AI-enabled virtual instructor:**
   Crew training / operation with no real-time support

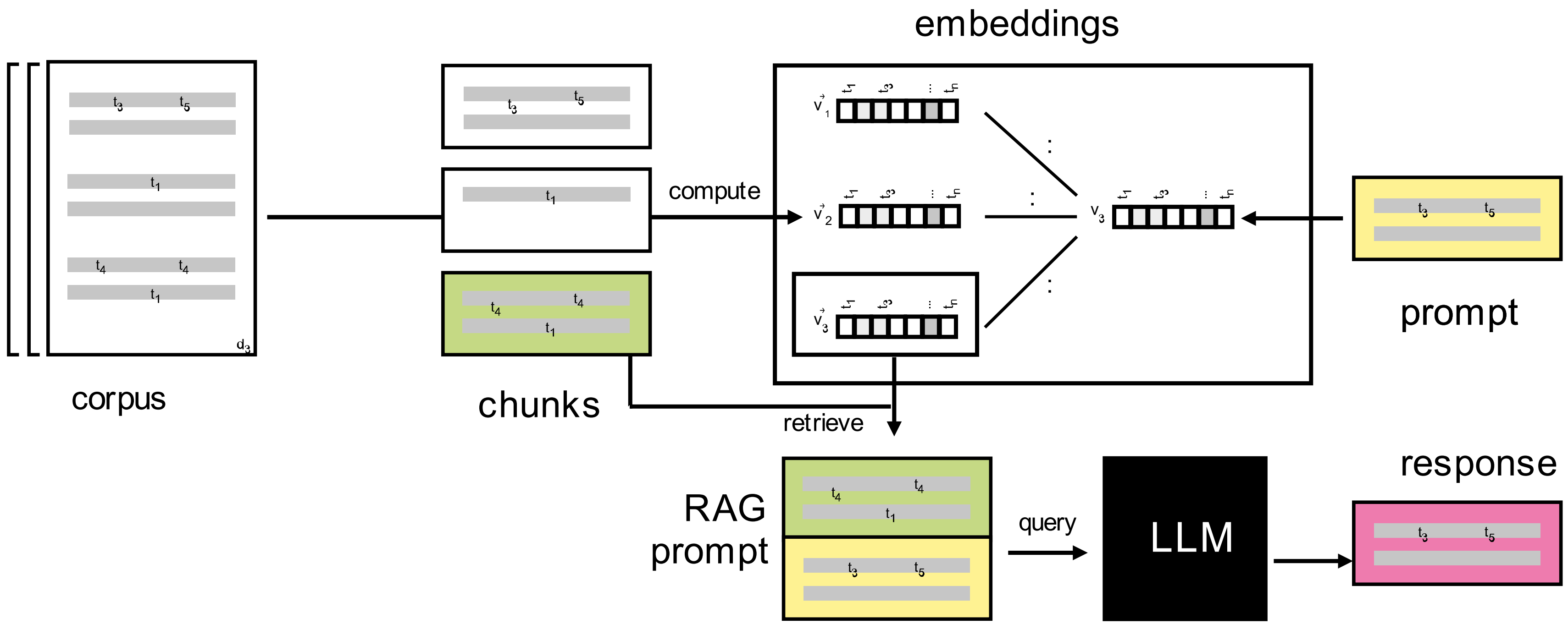


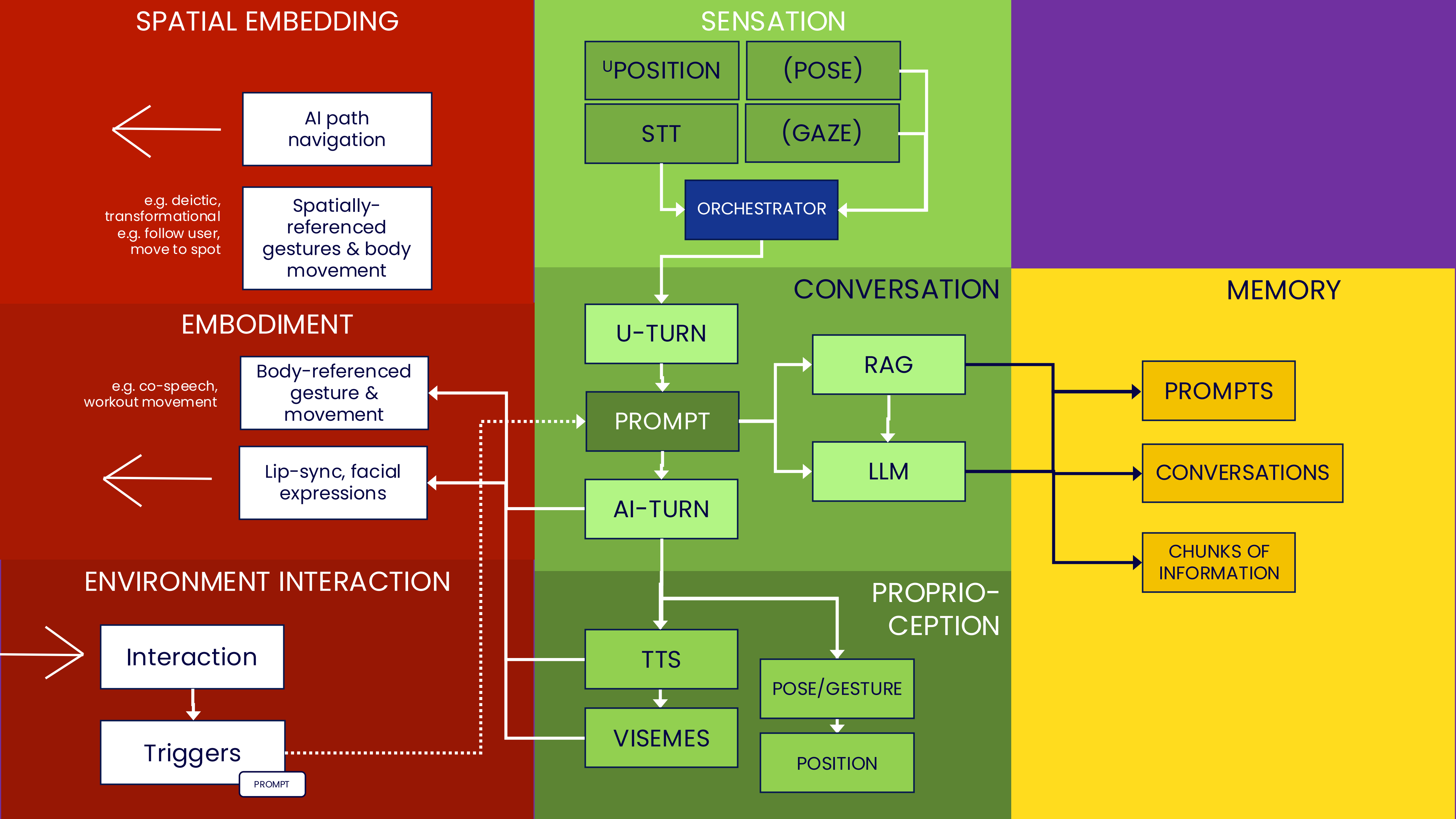


CARATE


Edit
Back to Home
Publish...
Activity (03/07/2024 18:34:08)
Steps
Info
Calibration
01 Action Step 1
Add task step description here...
Edit step
Add new step here
Activities
Profile
Help
Step Trigger
AI (chatGPT)
Record
Path Loop
Follow Player
Sitting
Loop
Delete
Clone
POLO SPORT

AI RAG ARCHITECTURE (Native RAG)





SPATIAL EMBEDDING
AI path navigation
e.g. deictic, transformational
e.g. follow user, move to spot
Spatially-referenced gestures & body movement
SENSATION
UPOSITION
(POSE)
STT
(GAZE)
ORCHESTRATOR
EMBODIMENT
e.g. co-speech, workout movement
Body-referenced gesture & movement
Lip-sync, facial expressions
CONVERSATION
U-TURN
PROMPT
AI-TURN
RAG
LLM
MEMORY
PROMPTS
CONVERSATIONS
CHUNKS OF INFORMATION
ENVIRONMENT INTERACTION
Interaction
Triggers
PROMPT
PROPRIO-CEPTION
TTS
VISEMES
POSE/GESTURE
POSITION

Pre-Interviews May-June: Findings: Identified Main Scenarios (interviews with 6 astronauts)

1. Enhanced Learning Through 3D Simulations: facilitate faster and more ecient learning of complex concepts, such as of a system or a module on the ISS or mission protocols; easier to visualise and comprehend.

2. Emergency Response Training: replace traditional cue cards with real-time AR visualisations. Astronaut could experience a simulated fire spreading visually within the virtual module, complete with audio cues. This immersive experience would help astronauts react more intuitively during real emergencies, honing their ability to quickly assess and respond to hazardous situations.

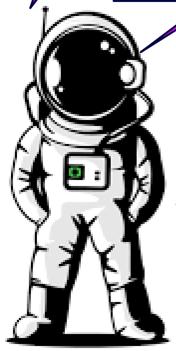
3. Hardware familiarization via 3D visualisation: assist in understanding the structure and functioning of hardware components through detailed 3D visualisations. For example, virtual model of a life-support system, inspecting individual parts and receiving in-depth information on each component. Help develop a deeper understanding of the hardware, which is crucial when conducting maintenance or troubleshooting onboard the ISS.

4. Performance feedback and corrective training: immediate feedback on performance. For instance, after performing a simulated extravehicular activity (EVA), the system could analyse the astronaut's actions, such as task accuracy and time taken, and provide specific feedback on areas that need improvement. This enables astronauts to refine their skills based on real-time analysis.

5. On-Demand Information Access: Access mission-critical information at any time during space missions, whether onboard the ISS or en route to a distant destination. This capability could streamline tasks such as mission planning, communications with ground control, and procedure execution by allowing astronauts to call up relevant data as needed, regardless of their physical location.

6. Maintenance and Structural Training: Cover critical lessons related to spacecraft structures, mechanical systems, and maintenance protocols. For example, an astronaut could practise disassemble and reassemble a module virtually, which would reinforce their understanding of both the process and the equipment involved.

7. Extra-Vehicular Activity (EVA) and Anatomy: help astronauts visualise their movements in relation to their surroundings. It could also provide virtual lessons on human anatomy, helping astronauts understand how their body reacts under different gravitational forces, such as those encountered on Mars or the Moon.



3. Can the System Help Prevent Mistakes During Training?

Potential for Error Prevention

- Many participants believed the system could effectively prevent errors in training if real-time feedback and monitoring were enhanced (P2, P4, P5, P7, P8, P10, P12).
- Several mentioned that such capabilities would help users identify and correct mistakes during practice sessions (P3, P6, P9).

Human Factors

- Some participants pointed out that human factors, such as user adaptability and cognitive load, need to be considered to ensure the system supports error prevention without overwhelming users (P1, P5, P8, P11).
- They noted that proper training on system use and interface design adjustments could help mitigate human errors (P2, P4, P7).

Unique Advantages of the System

- Participants highlighted that the system's immersive nature and its ability to simulate complex environments could provide unique advantages in training, offering scenarios that may be impractical in physical settings (P1, P3, P9, P12).
- They suggested that these capabilities could bridge the gap between theoretical knowledge and practical skills (P6, P8, P10).

Adaptability

- Some expressed the importance of the system's adaptability to different types of training tasks, stating that customization is necessary for it to be effective across various scenarios (P2, P5, P7, P10, P11, P12).

Pilot Findings (n=12, October 2024)

Ergonomics

Interaction

Space

Interaction

Locations

Conversational flow

SHIFT

KNOWHOW,
KNOW WHAT
AND
-> KNOW WHERE

Affect, empathy

Facial expressions

Body language

from EMBODIED to EMBEDDED cognition

Gesticulation

Motor memory

Proprioception

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