WEBINAR: The Ultimate Fusion: Extended Reality Meets Artificial Intelligence

Virtual agents: the convergence of AI & XR to characterize human cognition

XR2Industry Project

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UNIVERSITAT POLITÈCNICA DE VALÈNCIA

LENI Laboratory of Immersive Neurotechnologies

LENI

We research and develop solutions for a better understanding of human cognition combining computer science, psychology and neuroscience.

We are a multidisciplinary research team joining efforts to shape the future of:

#Embodiment

PSYCHOLOGY/NEUROSCIENCE OF XR

Presence, embodiment, persuasive training, immersive learning, virtual humans, neurodesign, immersive analytics,….

APPLICATIONS

Health, Management, Retail, Bank, Industry,…

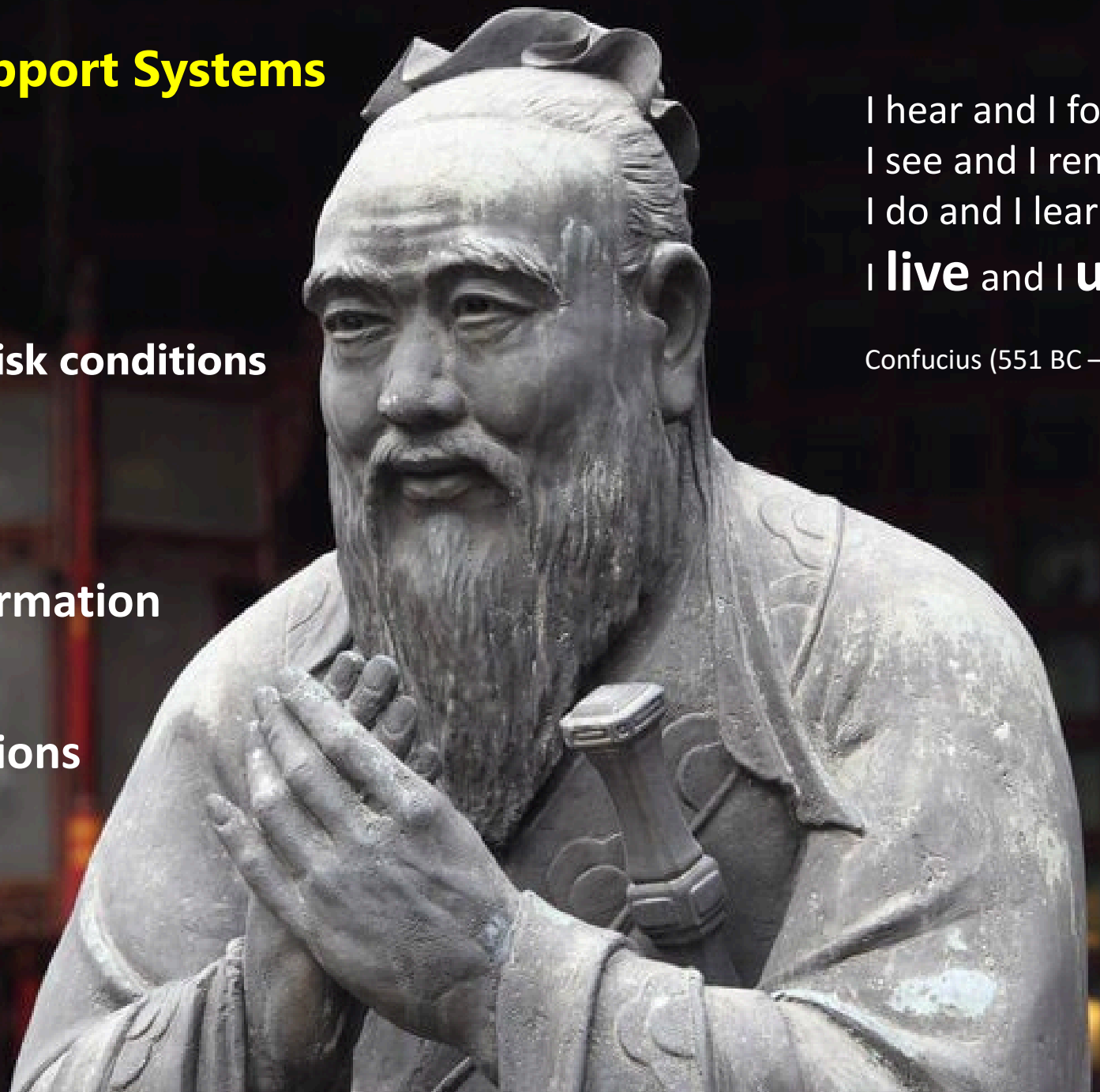
Behaviour Change Support Systems (BCSS)

- VRET therapy
- Avatar therapy
- Decision taking under risk conditions
- ..

Why does BCSS work?

How the brain process information
Predictive coding theory

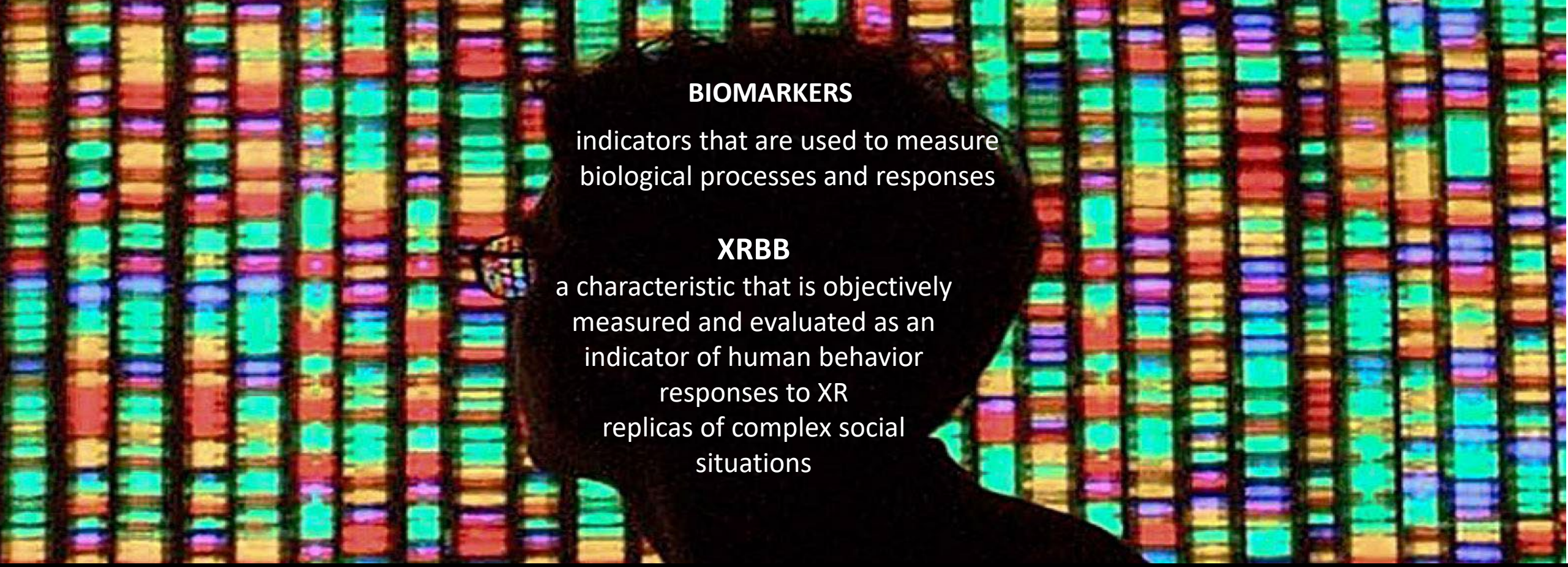
How the brain makes decisions
Dual processing theory



I hear and I forget
I see and I remember
I do and I learn
I **live** and I **understand**

Confucius (551 BC – 478 BC)

01 XRBB: concept & methodology



BIOMARKERS

indicators that are used to measure biological processes and responses

XRBB

a characteristic that is objectively measured and evaluated as an indicator of human behavior
responses to XR
replicas of complex social situations

MENTAL HEALTH

RDoC
Autism/schizophrenia

COMPUTATIONAL PSYCHIATRY

HUMAN RESOURCES ORGANIZATIONAL BEHAVIOR

ORGANIZATIONAL NEUROSCIENCE

MARKETING

CONSUMER NEUROSCIENCE

What are XRBB?

OBJECTIVE: TO IMPROVE/LEARN NEW SKILLS

XRBB METHODOLOGY
REPLICAS OF COMPLEX SOCIAL SITUATIONS

Demographics
Personality
Psychological traits
Lifestyles
....

Biosignals (GSR, eye tracking, voice,..)

Behavioral Metrics (decisions, reaction times,..)

Machine Learning Techniques

XR BEHAVIORAL BIOMARKERS

ASSESSMENT/ ADAPTIVE VARIABLES (Psychological dimensions)

TO CREATE NEW ADAPTED REALITIES

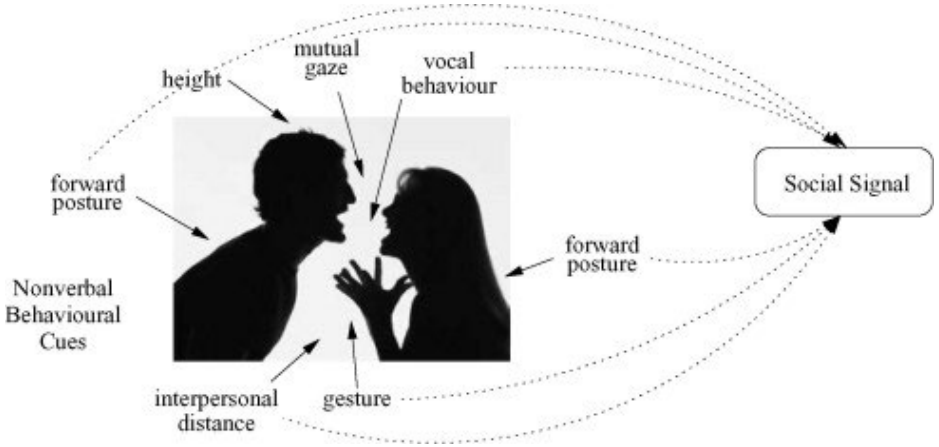
XR contents for human cognition characterization

XRBB APPLICATIONS

- Patients
- Health Practitioners (communication skills with patients)
- Corporate leaders
- …

CONTENTS
Mainly Virtual Humans

- Mainly Virtual Humans:
- A patient with depression/schizophrenia
- An autistic child
- People at work
- …



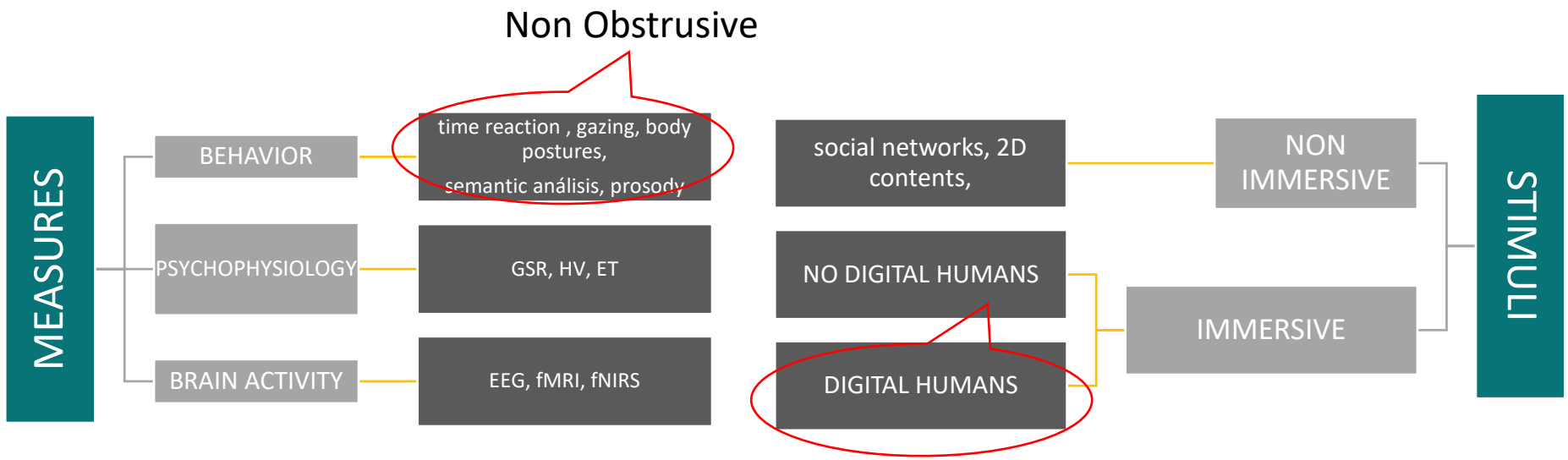
METRICS
How good were you empathizing with a patient?

- Psychometric tests /self Reports
  - Biased
  - Social desirability
  - Hard to understand

OBJECTIVE HUMAN BEHAVIOR METRICS

- Direct brain activity
- Indirect brain activity (behaviors,..)
- Real-time

Stimulies and Measures



FROM ROBOTS TO VIRTUAL AGENTS

CONVERSATIONAL AGENT

2D interfaces possess many characteristics of a face-to-face conversation between humans including the ability to respond to verbal and non-verbal information (Casell et al, 2000)

INTELLIGENT VIRTUAL AGENT

3D interfaces that exhibit quasi-human qualities and can communicate with humans and other agents using human modalities such as speech, facial expressions, and gestures. They have real-time perception, cognition, emotion, and actions (Iva, 2019)

INTELLIGENT SOCIAL AGENTS

Intelligent virtual agents display a certain style of human social intelligence (Dautenhahn, 2003)

DIGITAL HUMANS (DH)

An outstanding VE content to deploy natural behavior

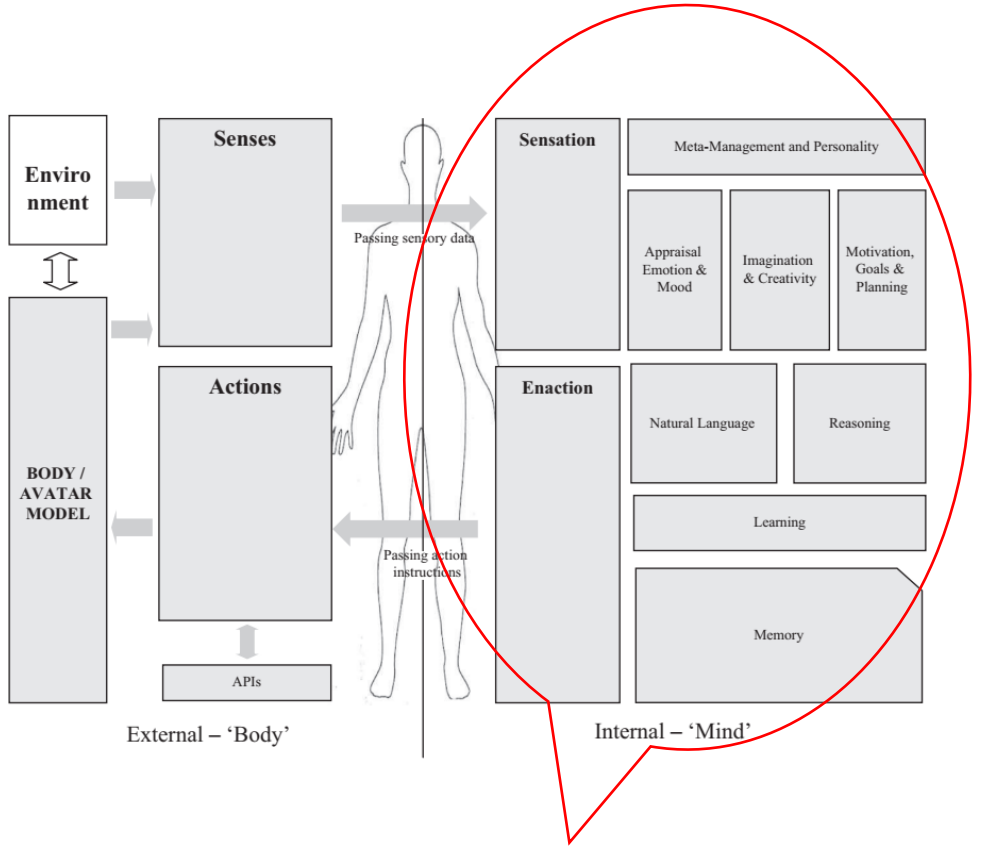
Our brain is hardwired for social interactions (“social brain”, theory of mind,..)

Needs to simulate Verbal behavior (VB) and Non Verbal Behavior (NVB)

NVB conveys more than 70% of social information

DH must present a “social brain” (empathy, theory of mind,..)

Cognitive architectures: VB and NVB



COGNITIVE ARCHITECTURES

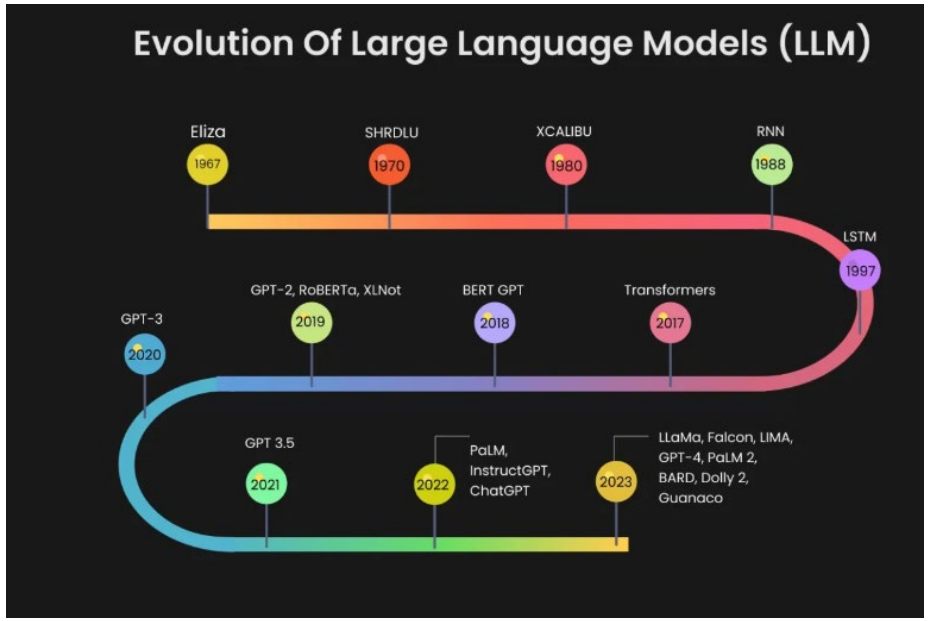
COGNITIVE ARCHITECTURES STATE OF THE ART

VERBAL BEHAVIOR

Rapid advancements in LLM

Recent LLM interprets emotional expressions and generate empathic responses.

BUT: black boxes, data-driven, no control for "non-standard" samples (mental health, organisational behaviour, etc.)



NON-VERBAL BEHAVIOR

Several classical approaches for cognitive architectures

BUT: lack of a general model for "social brain" behaviours. We still don't have a general model of artificial empathy.

hume

INPUT SENSES

Multisensorial inputs (text, voice, images, videos)

VERBAL BEHAVIOR

Hybrid Empathetic Framework (HEF)

Current LLMs excel in response expression, **BUT**
They cannot deeply understand emotional and cognitive nuances

Small-scale empathetic models (SEMs) strengthen fine-grained emotion detection and detailed emotion cause identification.

HEF regards SEMs as flexible plugins to improve LLM's nuanced emotional and cognitive understanding

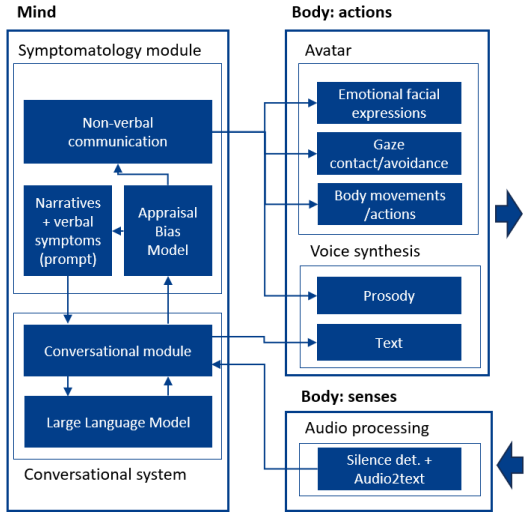
A two-stage emotion prediction strategy:

- Encouraging LLMs to prioritise primary emotions emphasised by SEMs

- Cognitive understanding:

An emotion-cause perception strategy, **prompting** LLMs to focus on crucial emotion-eliciting words identified by SEMs

Complementary Capabilities for Empathy	SEMs	LLMs
Fine-grained emotion detection (Affection)	Stronger	Weaker
Detailed emotion cause identification (Cognition)	Stronger	Weaker
Response generation	Weaker	Stronger



NON VERBAL BEHAVIOR

Cognitive Approach of Emotions (CAE)

Result of a process of evaluation of the situation by an individual (CAE)

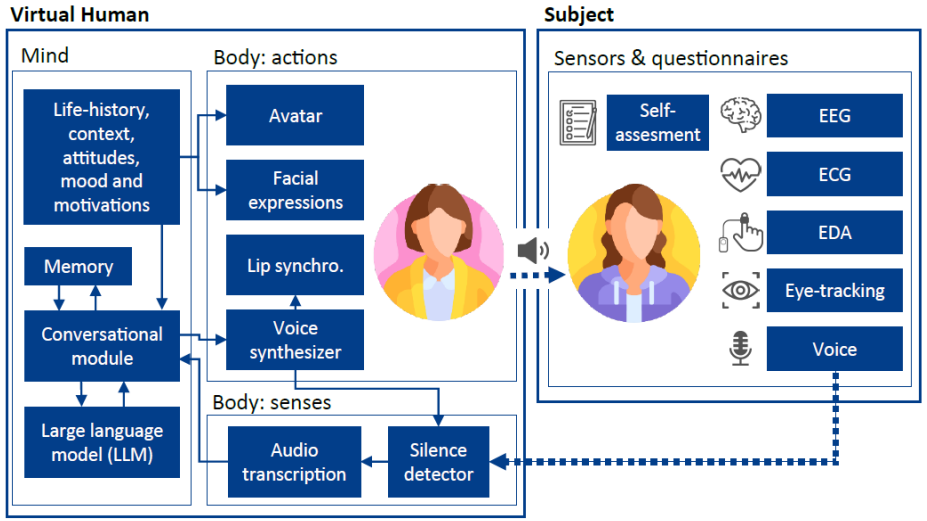
The evaluation criteria is based on the **Component Process Model (CPM)**

The representation of emotional behaviors of the VH, is based on the **Appraisal Bias Model (ABM).** The ABM model, considers individual characteristics as appraisal biases

In our model, the mood of the VH is represented by a configuration of the state of appraisal variables:

- Text
- States
- Triggers

This configuration evolves during the interaction according to the successive evaluations made by the VH



Thank you!

Questions?
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