# AGIs and WBEs in SPACE

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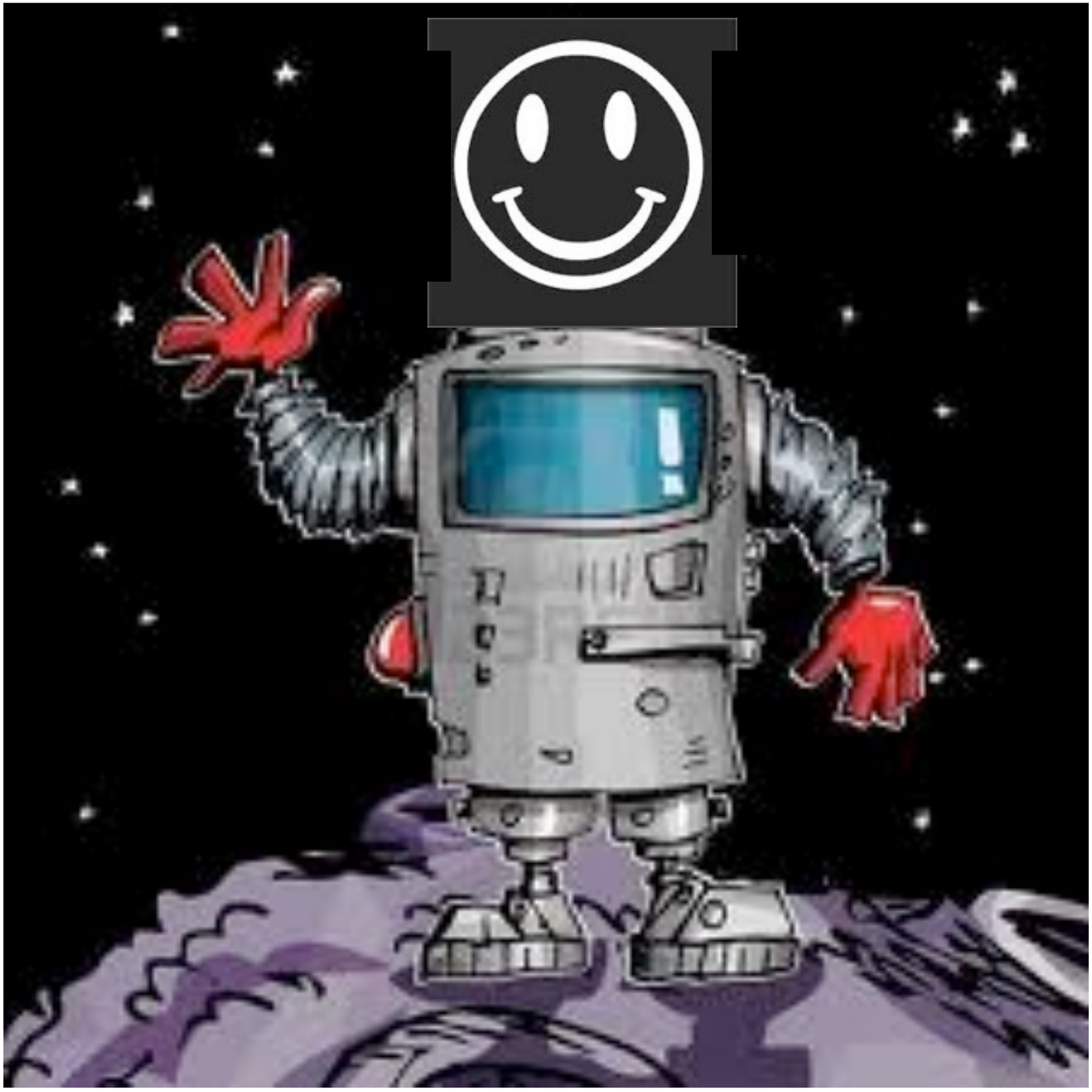


- Artificial General Intelligence in Space
- Whole Brain Emulations in Space
- Spacefaring Virtual Realities
- Space & the Transcension Hypothesis

# Artificial General Intelligence

# Artificial General Intelligence (AGI)

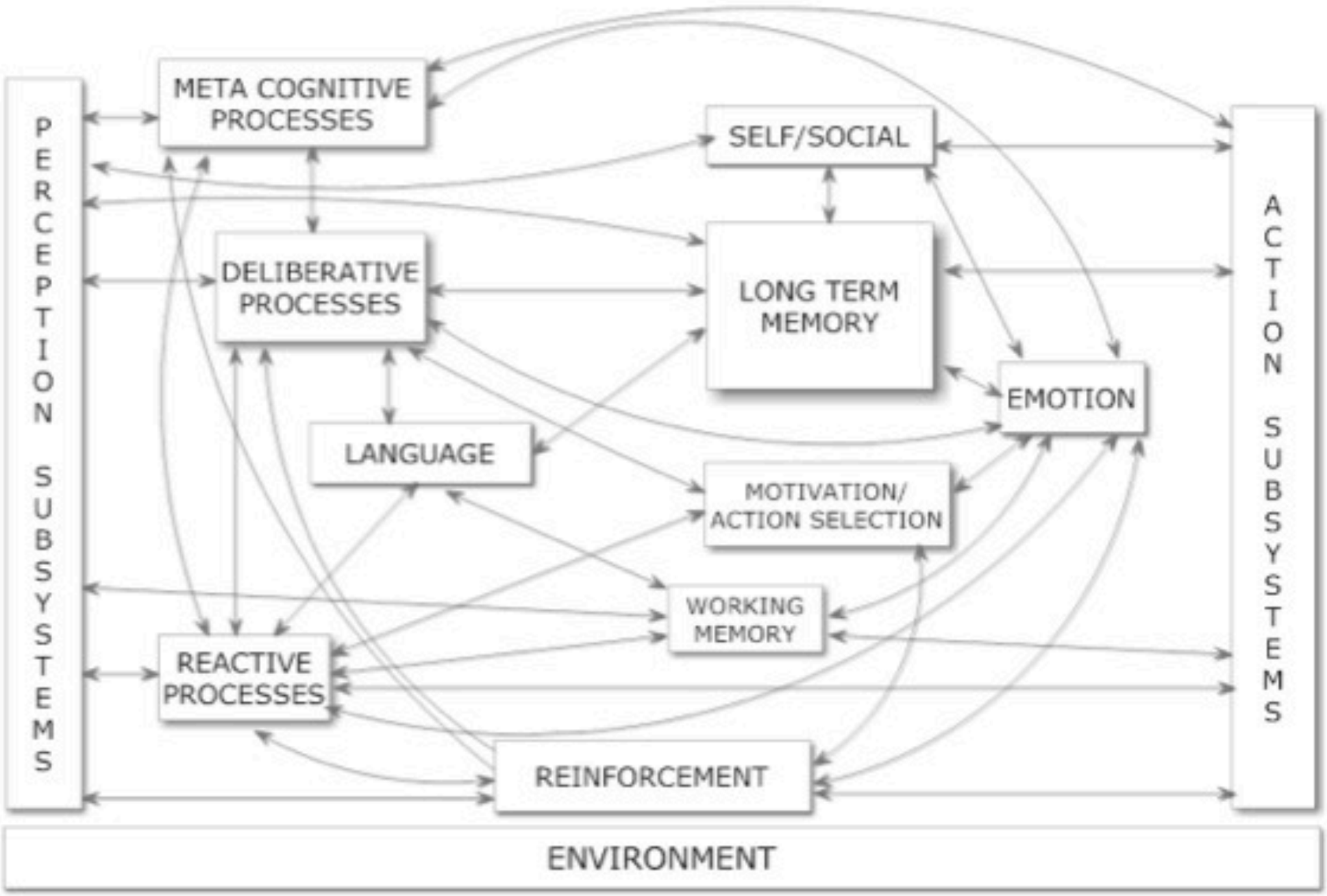
Humans are, in a certain sense, general-purpose rather than narrowly specialized intelligences…

General intelligence may be loosely conceived as

> *"The ability of a system to achieve a variety of complex goals in a variety of complex environments using limited computational resources -- including goals and environments that were not anticipated at the time the system was created."*

...
**AGI-11**: Google, Mountain View CA, Aug 2011
**AGI-12**: Future of Humanity Institute, Oxford University, UK, Dec 2012
**AGI-13**: Beijing, China, August 2013 (adjacent to IJCAI)

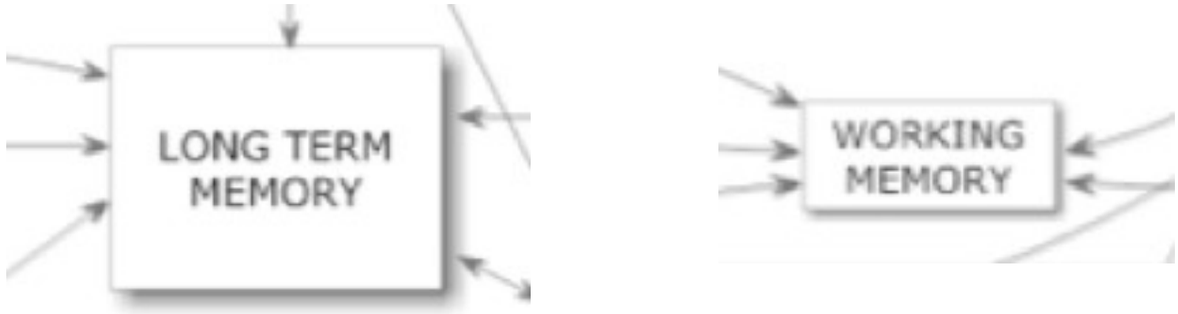
# High-Level Human Mind Architecture



# Knowledge Representation in OpenCog

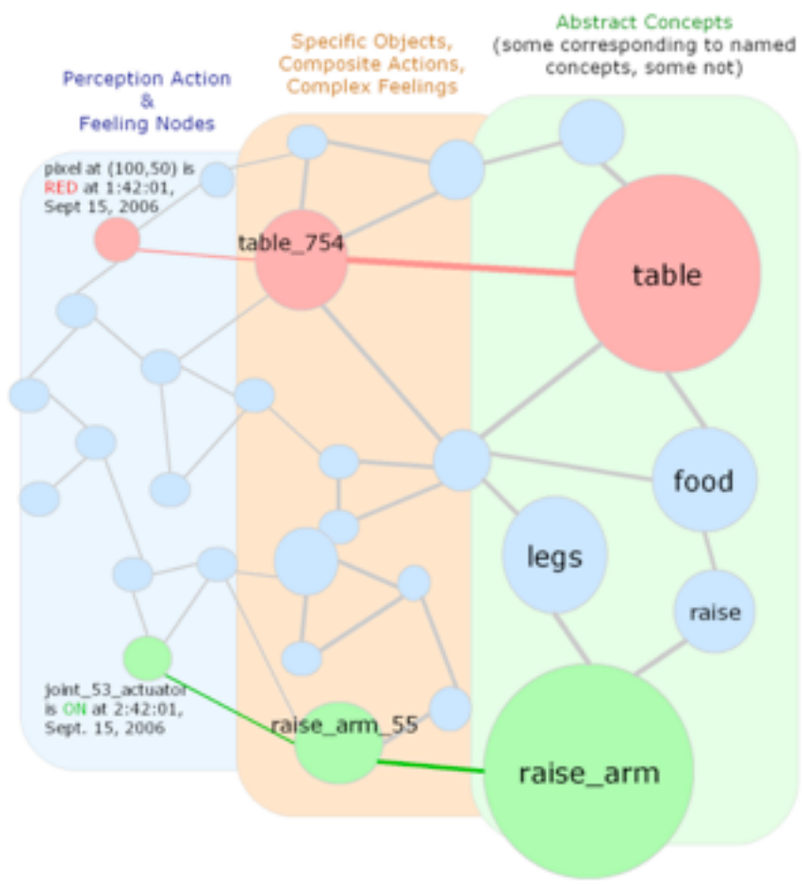
**Explicit knowledge representation**:

Nodes and links (collectively "Atoms") that explicitly encode individual pieces of knowledge

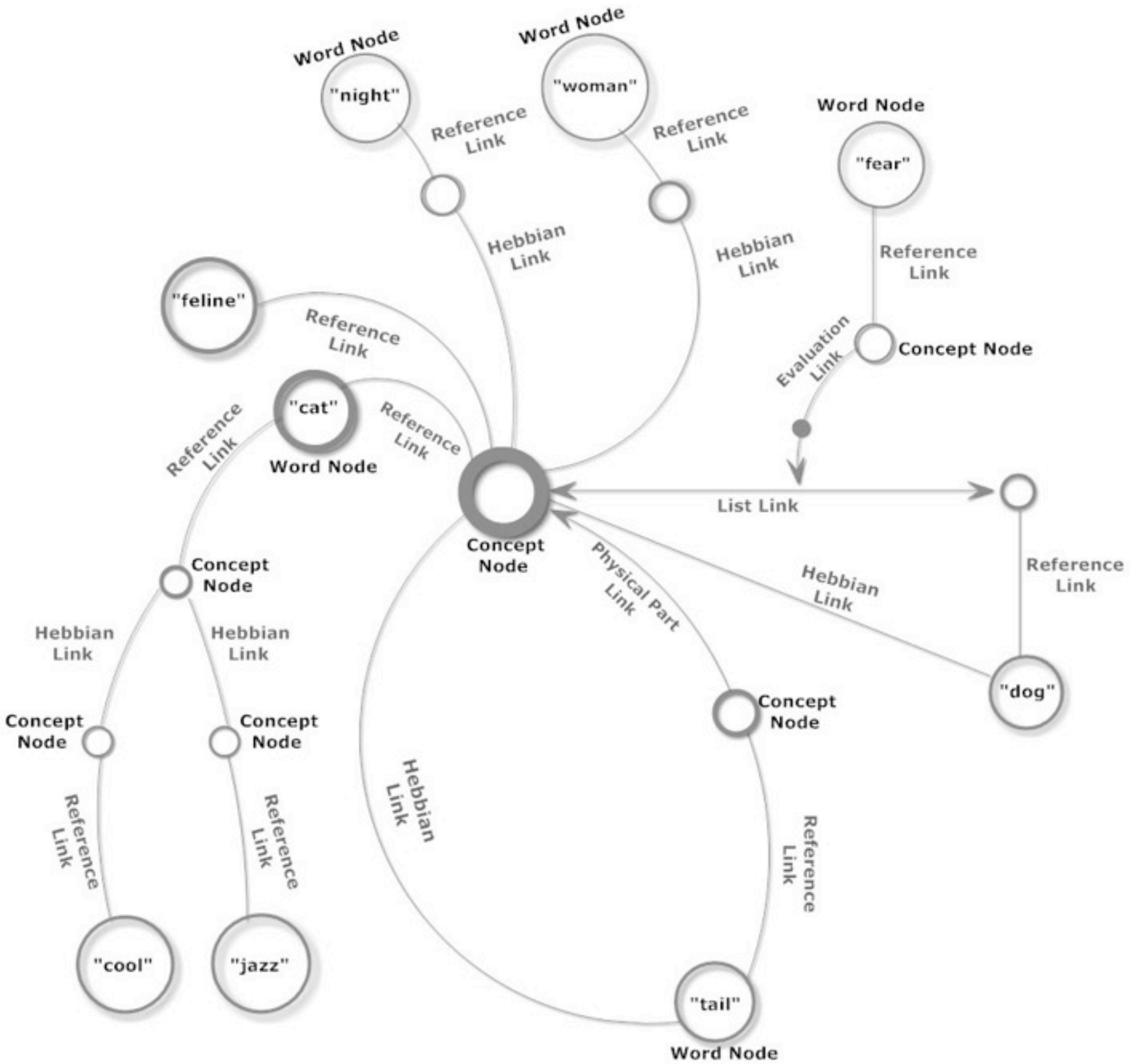



**Implicit knowledge representation**:

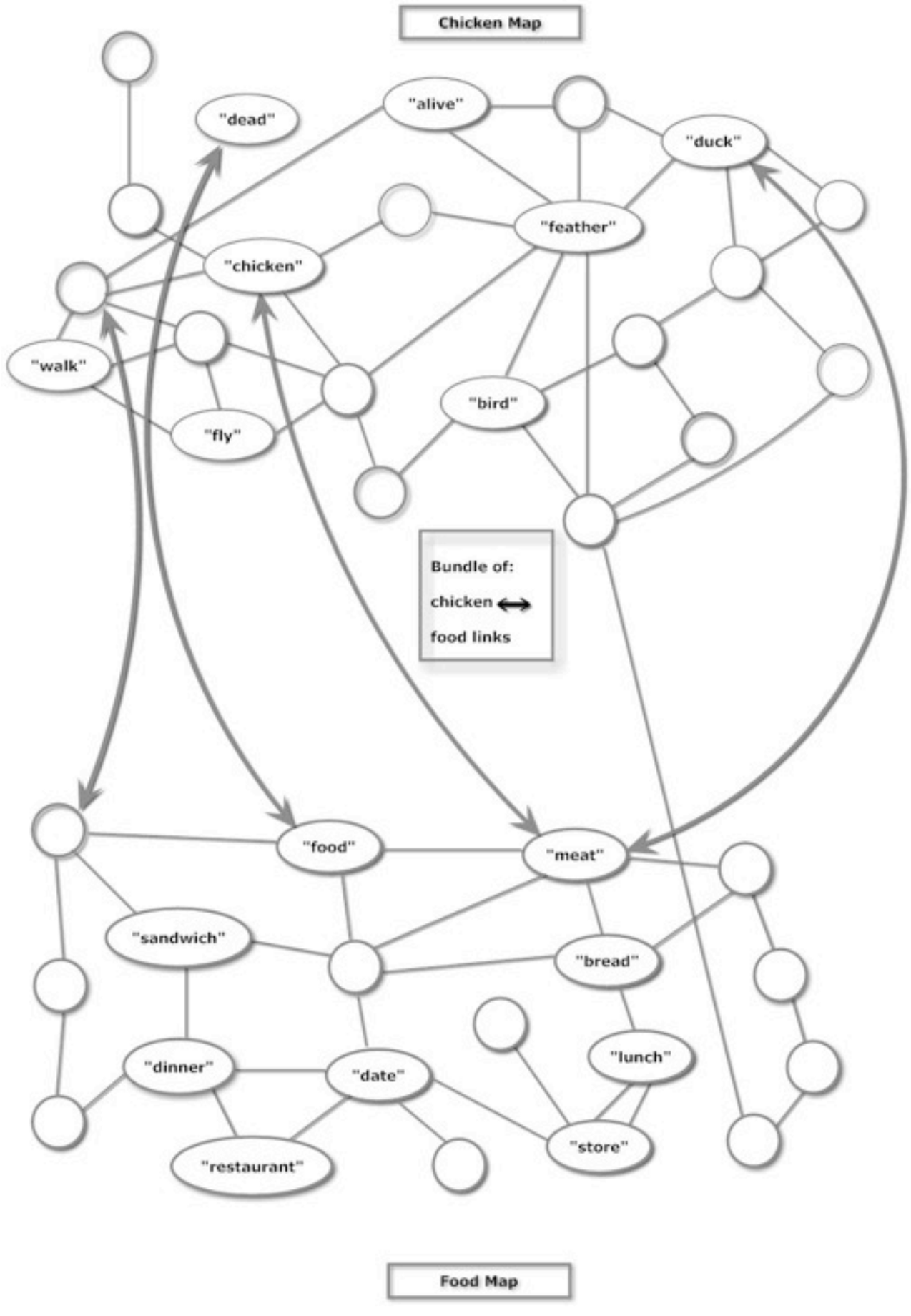
Knowledge that is encoded in the coordinated structure or activity of a large set of nodes and links

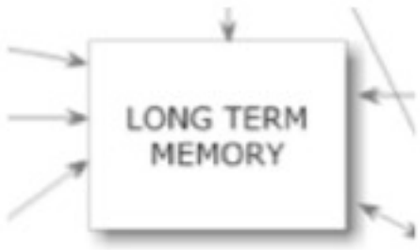


# Explicit


Word Node
"night"
Word Node
"woman"
Word Node
"fear"
Reference Link
Reference Link
Hebbian Link
Hebbian Link
Reference Link
"feline"
Reference Link
Evaluation Link
Concept Node
"cat"
Reference Link
Reference Link
Word Node
List Link
Concept Node
Concept Node
Physical Part Link
Hebbian Link
Reference Link
Hebbian Link
Hebbian Link
"dog"
Concept Node
Concept Node
Concept Node
Reference Link
Reference Link
Hebbian Link
Reference Link
"cool"
"jazz"
"tail"
Word Node

# Implicit


Chicken Map
"dead"
"alive"
"duck"
"feather"
"chicken"
"walk"
"bird"
"fly"
Bundle of:
chicken ⟷
food links
"food"
"meat"
"sandwich"
"bread"
"dinner"
"date"
"lunch"
"store"
"restaurant"
Food Map





# cognitive synergy in OpenCog

Declarative
Probabilistic Logic Networks, concept blending, language comprehension & generation

Procedural
MOSES (probabilistic evolutionary learning), hillclimbing

Attentional/ Intentional
economic attention networks, adaptive goal hierarchy

Sensory
hierarchy of memory/ processing units

Episodic
internal world simulation engine

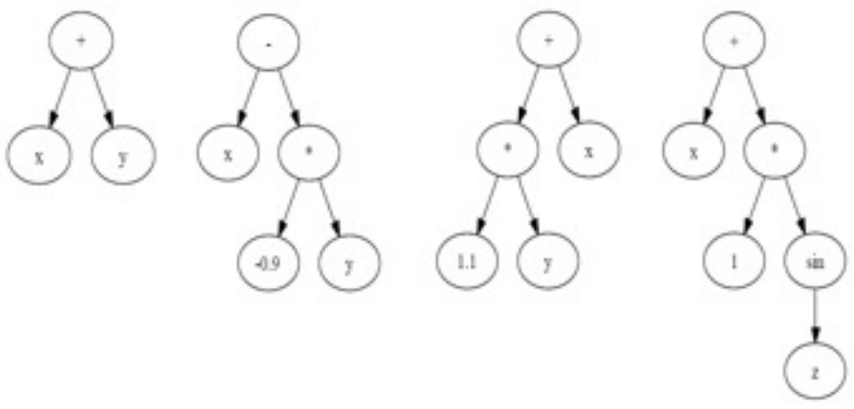
# Two Key Algorithms for Procedural and Declarative Knowledge Creation

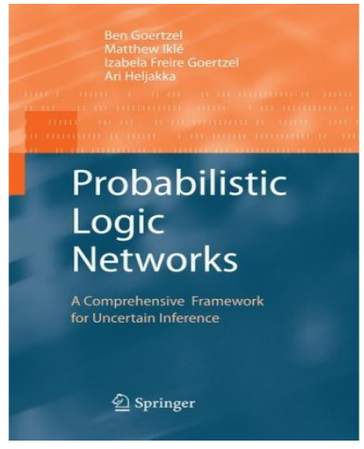
## MOSES Probabilistic Evolutionary Learning

Combines the power of two leading AI paradigms: evolutionary and probabilistic learning

Extremely broad applicability. Successful track record in bioinformatics, text and data mining, and virtual agent control.

Moshe Looks 2006 PhD thesis: metacog.org



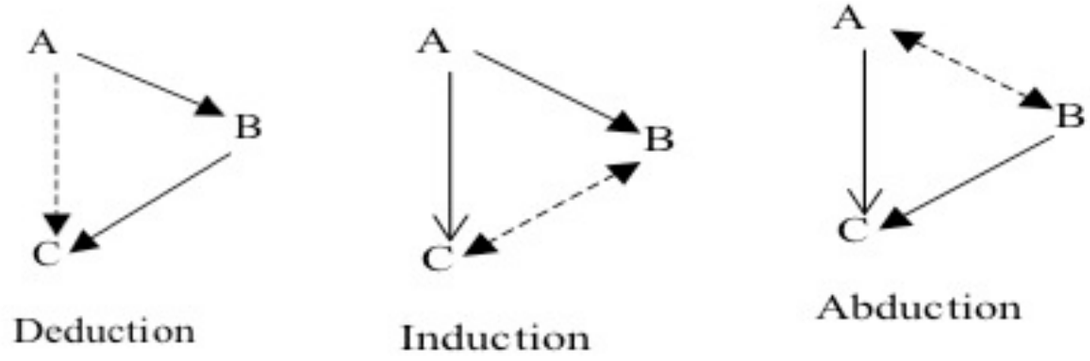



## Probabilistic Logic Networks

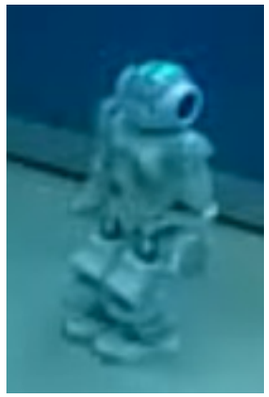
A highly general, practical integration of probability theory and symbolic logic.

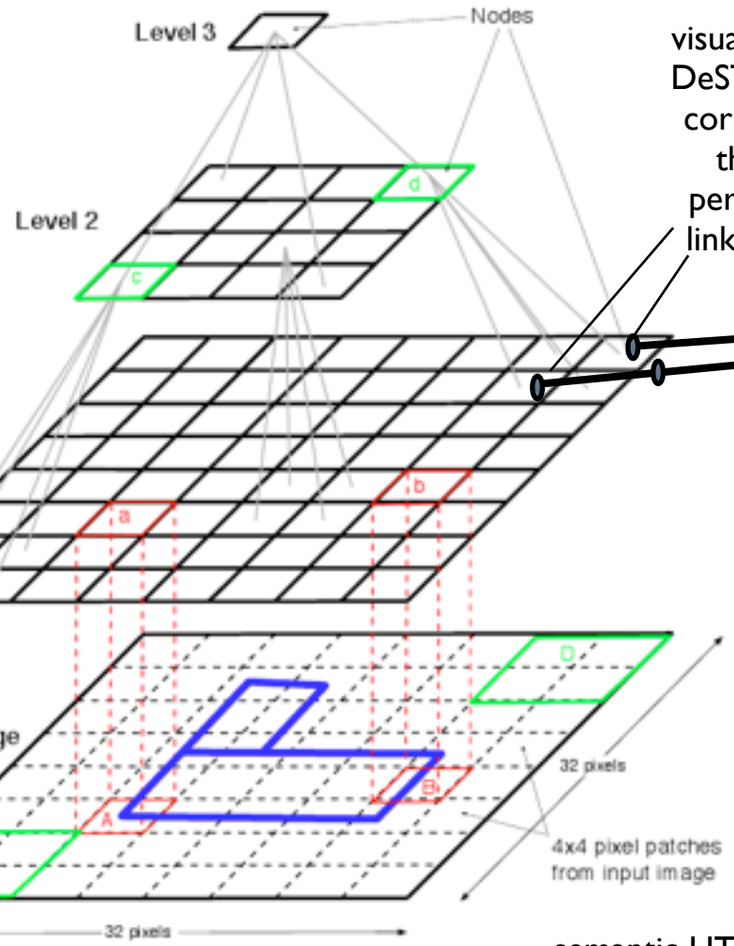
Extremely broad applicability. Successful track record in bio text mining, virtual agent control.

Based on mathematics described in *Probabilistic Logic Networks*, published by Springer in 2008



# CSDLN = "Compositional Spatiotemporal Deep Learning Network, e.g. HTM, DeSTIN,...



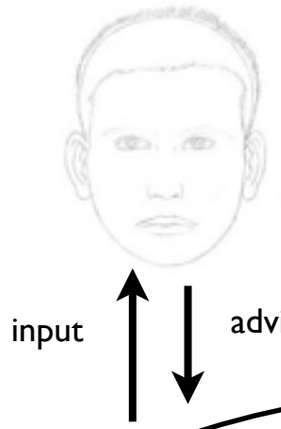



PERCEPTUAL CSDLN

visual patterns (e.g. DeSTIN centroids) corresponding to the semantic perception node linked to "human eye"

semantic HTM nodes/links formed by pattern mining perceptual HTM

semantic HTM provides probabilistic biasing to perceptual HTM



input

advice

COGNITIVE SEMANTIC NETWORK

concept node

reference link

"human eye"

phrase node

reference link

reference link

aligned on axis perpendicular to mouth-nose-eyes axis

between

below

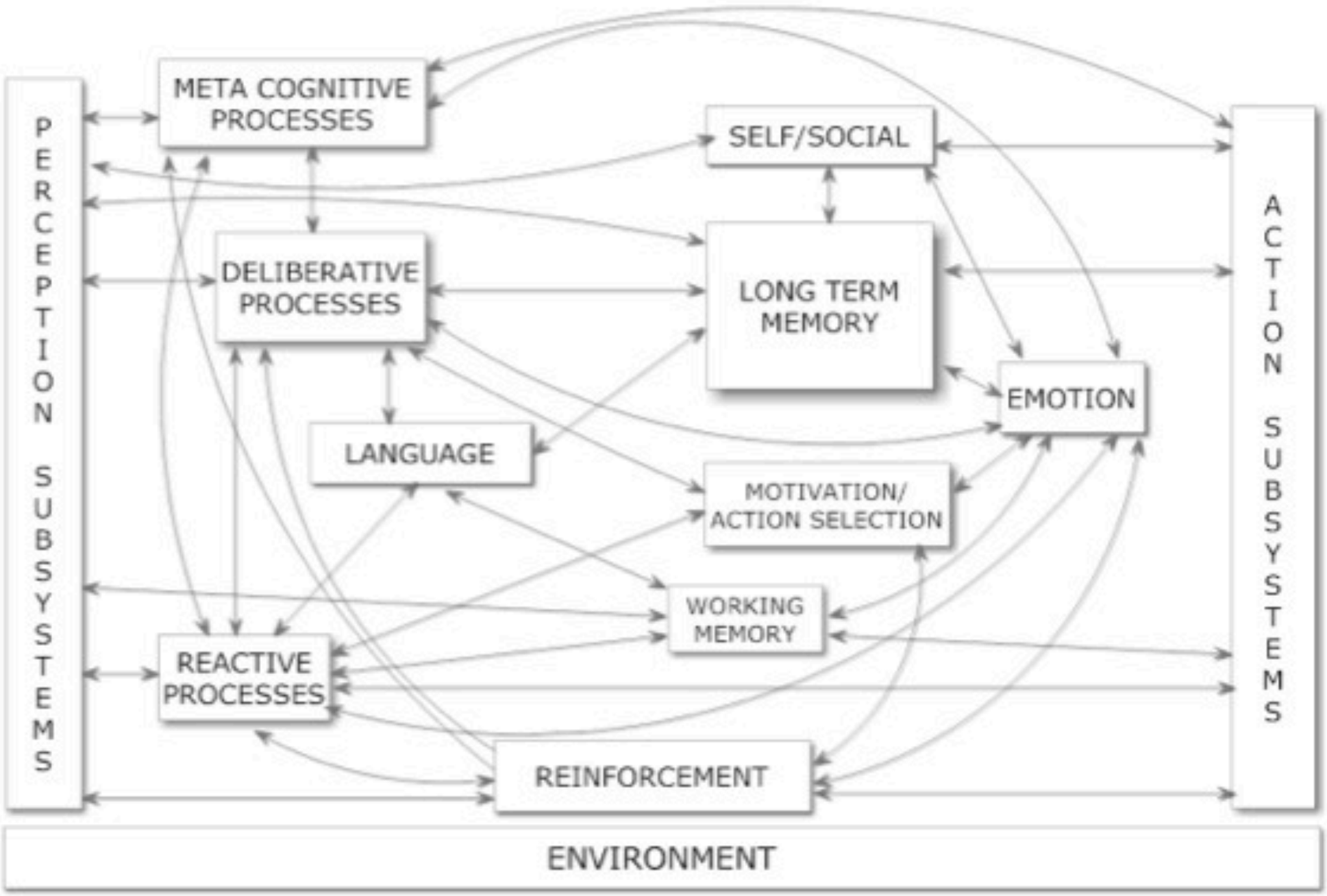
below

aligned on axis perpendicular to eyes axis

below

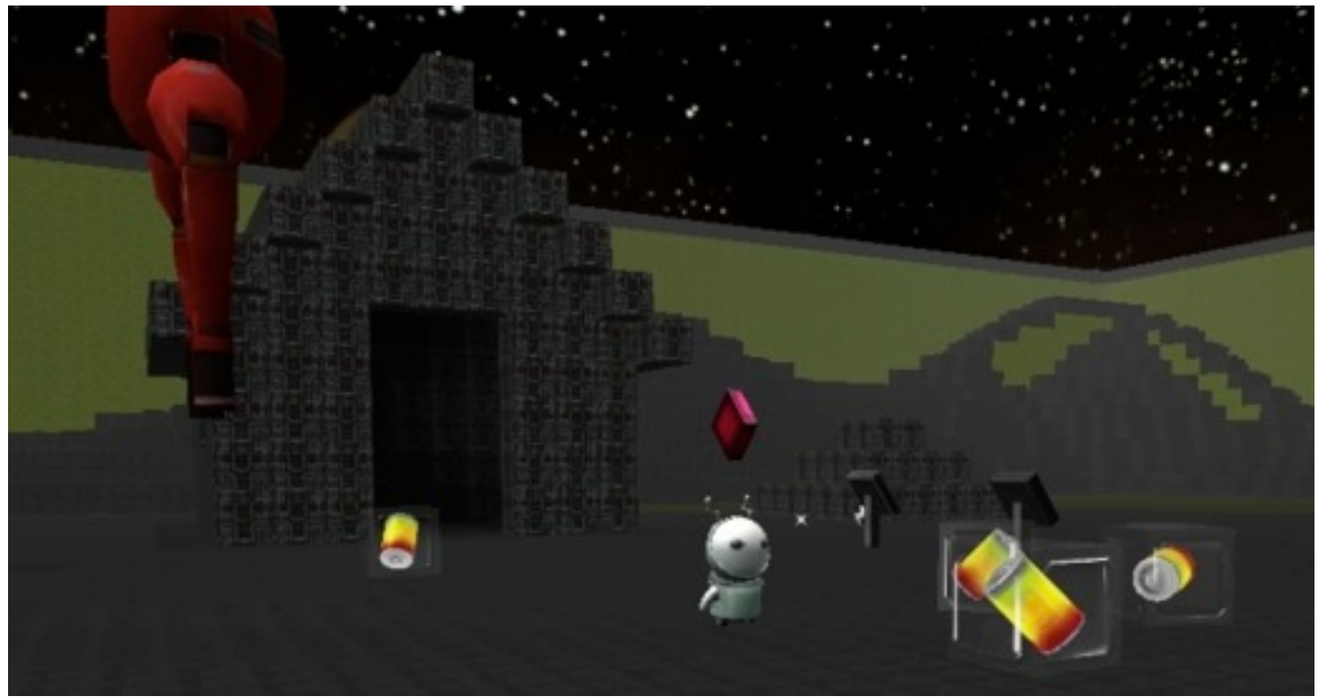
SEMANTIC-PERCEPTUAL CSDLN

# High-Level Human Mind Architecture



# OpenCog Hong Kong Project

- At Hong Kong Polytechnic University's "M-Lab", co-sponsored by the Hong Kong Innovation in Technology Fund and Novamente LLC
- OpenCog used to control animated agents in a video game world
- Game world built in Unity3D, modeled roughly on Minecraft



Goals include:

- perfecting the use of "greedy pattern mining" to find patterns in a world, suitable for feeding into abstract cognitive algorithms (and feedback from abstract cognition to guide pattern mining)
- perceptually grounded PLN inference (deduction, induction, analogy,...)
- creative goal-driven learning of complex multi-part actions
- simple grounded English dialogue


**This shows OpenCog oscillating between the robot's "home" and batteries, as a result of its quests to fulfill integrity and energy demands respectively. After a few movements back and forth, it also shows the Psi monitor updating graphs of the Psi variables (note the updates are synchronized between graphs).**

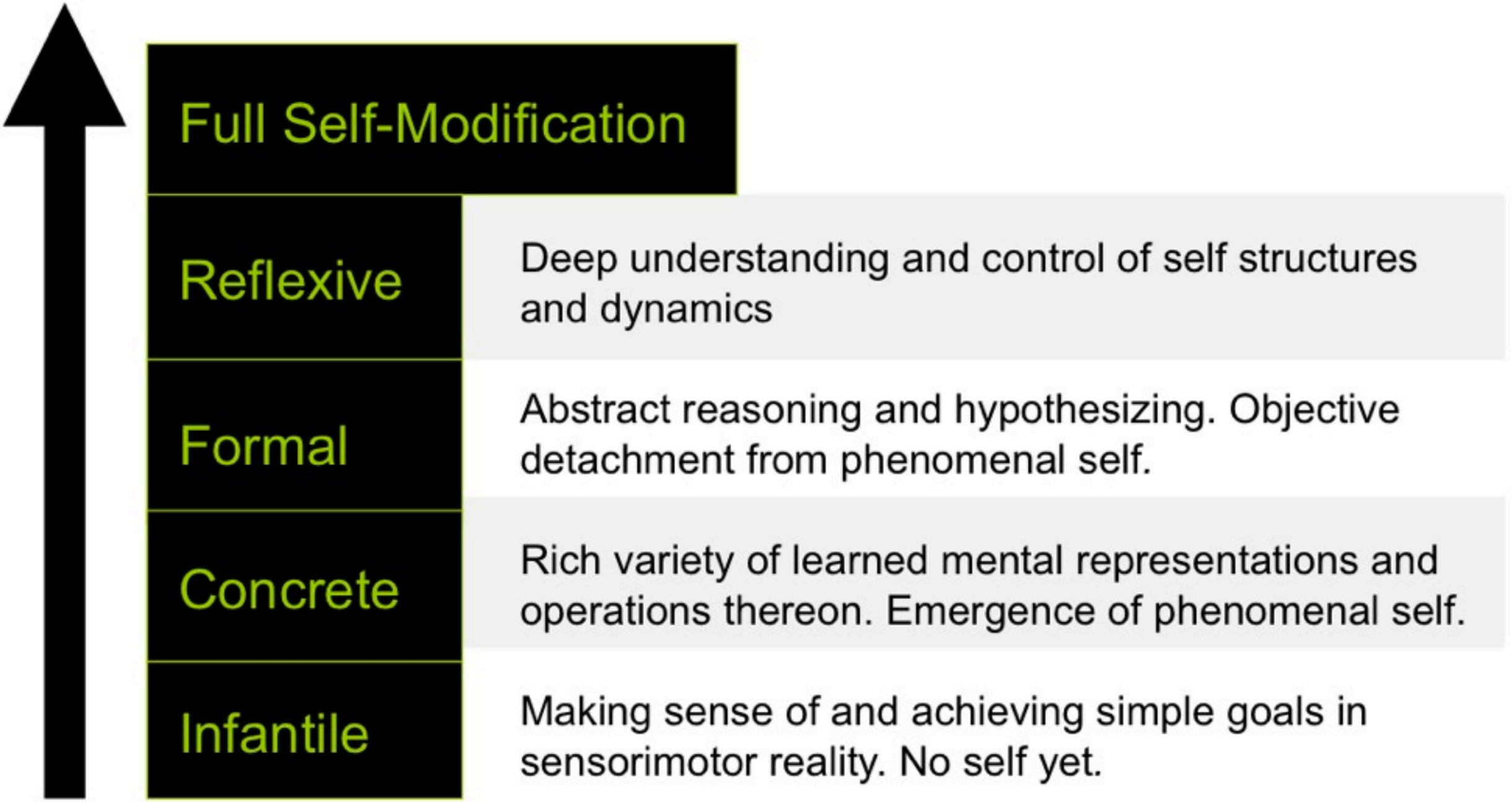
# *What's Missing in OpenCog HK?*

(even after lots of difficult, current work-in-progress gets finished !!)

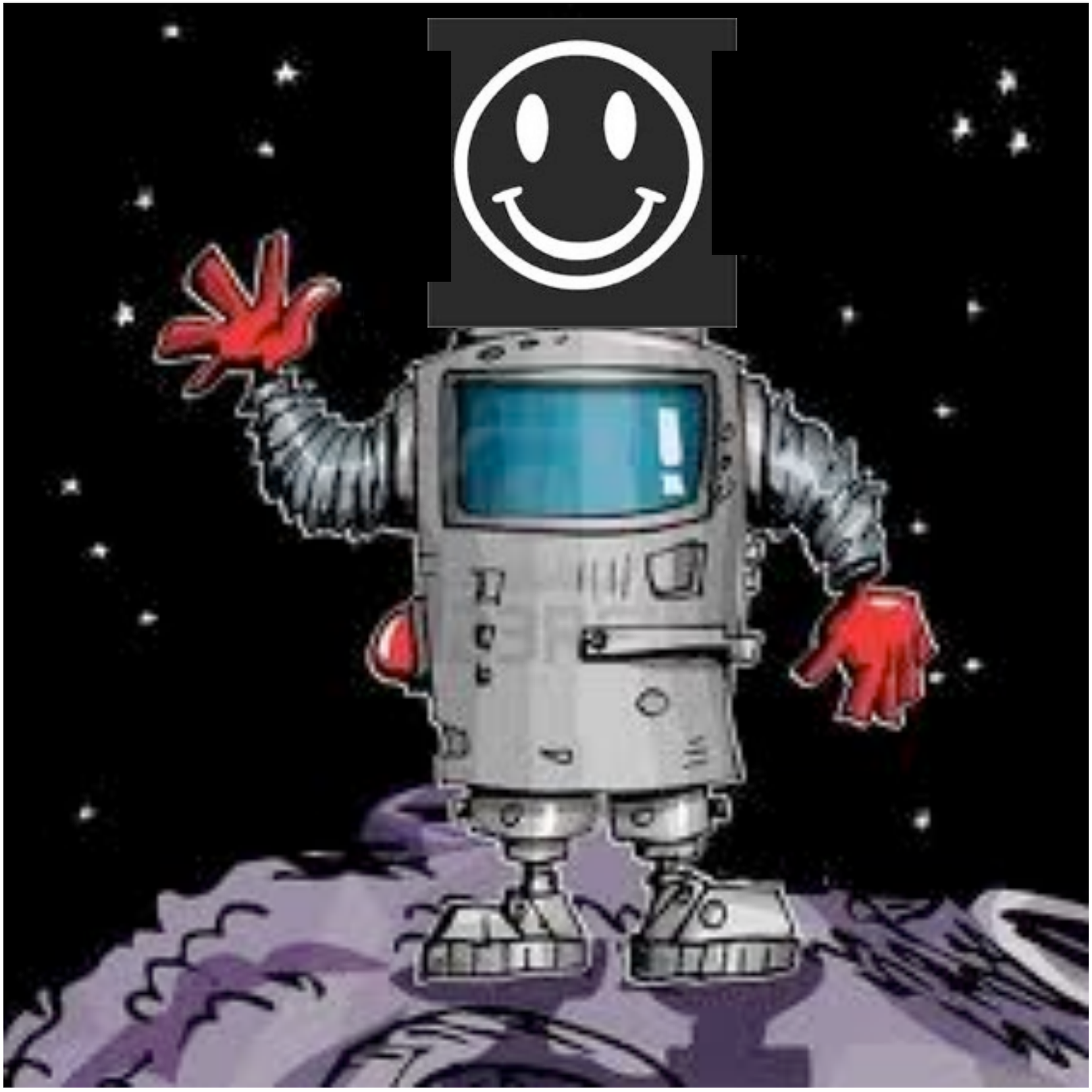
- Rich perceptual data
- A rich set of motoric affordances

- Preliminary work has been done using the same software to control a Nao humanoid robot
- One direction for future work is to integrate sophisticated perception and action processing into OpenCog to enable more thorough exploitation of robotic embodiment

# Piagetan Stages of Development



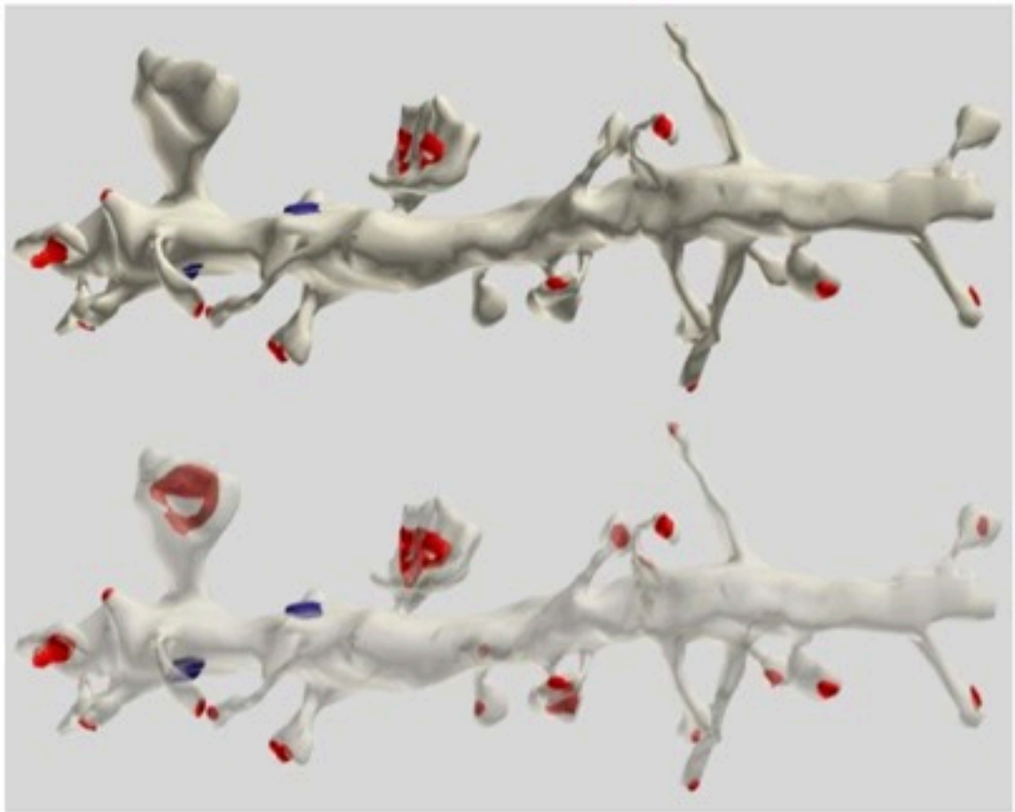
- **2011-2012**: A Proto-AGI Virtual Agent
- **2013-2014**: A Complete, Integrated Proto-AGI Mind (Piagetan concrete)
- **2015-2016**: Advanced Learning and Reasoning (Piagetan formal)
- **2017-2018:** AGI Experts
- **2019-2021**: Full-On Human Level AGI
- **2021-2023:** Advanced Self-Improvement (Piagetan reflexive)



# Whole Brain Emulation

# Whole Brain Emulation

## A Roadmap



(2008) *Technical Report #2008-3*

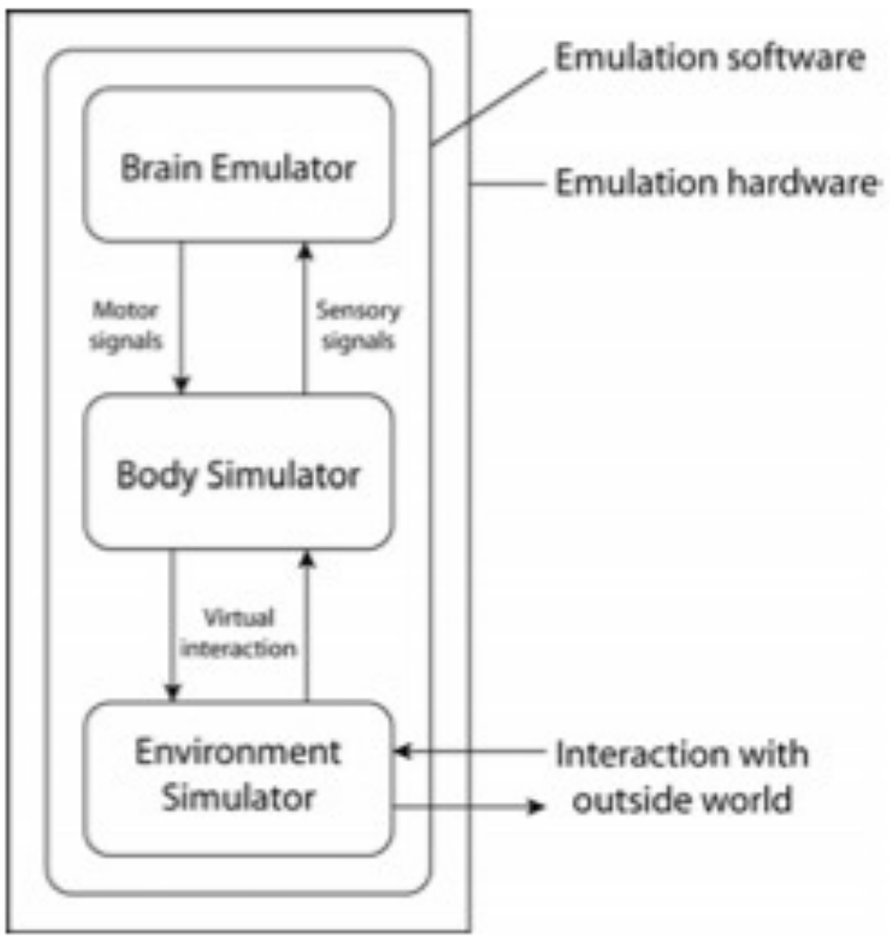
**Anders Sandberg***
**Nick Bostrom**

**Future of Humanity Institute**
**Faculty of Philosophy & James Martin 21st Century School**
**Oxford University**

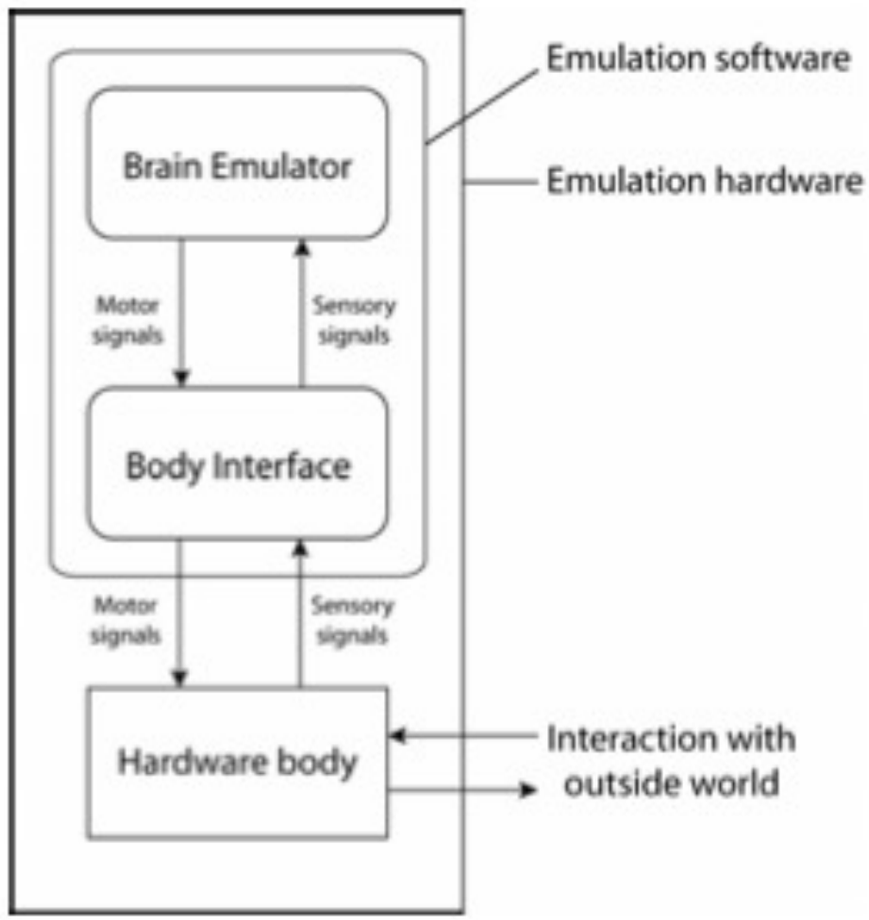
CITE: Sandberg, A. & Bostrom, N. (2008): *Whole Brain Emulation: A Roadmap*, Technical Report #2008-3, Future of Humanity Institute, Oxford University
URL: www.fhi.ox.ac.uk/reports/2008-3.pdf

**(*) Corresponding author: anders.sandberg@philosophy.ox.ac.uk**

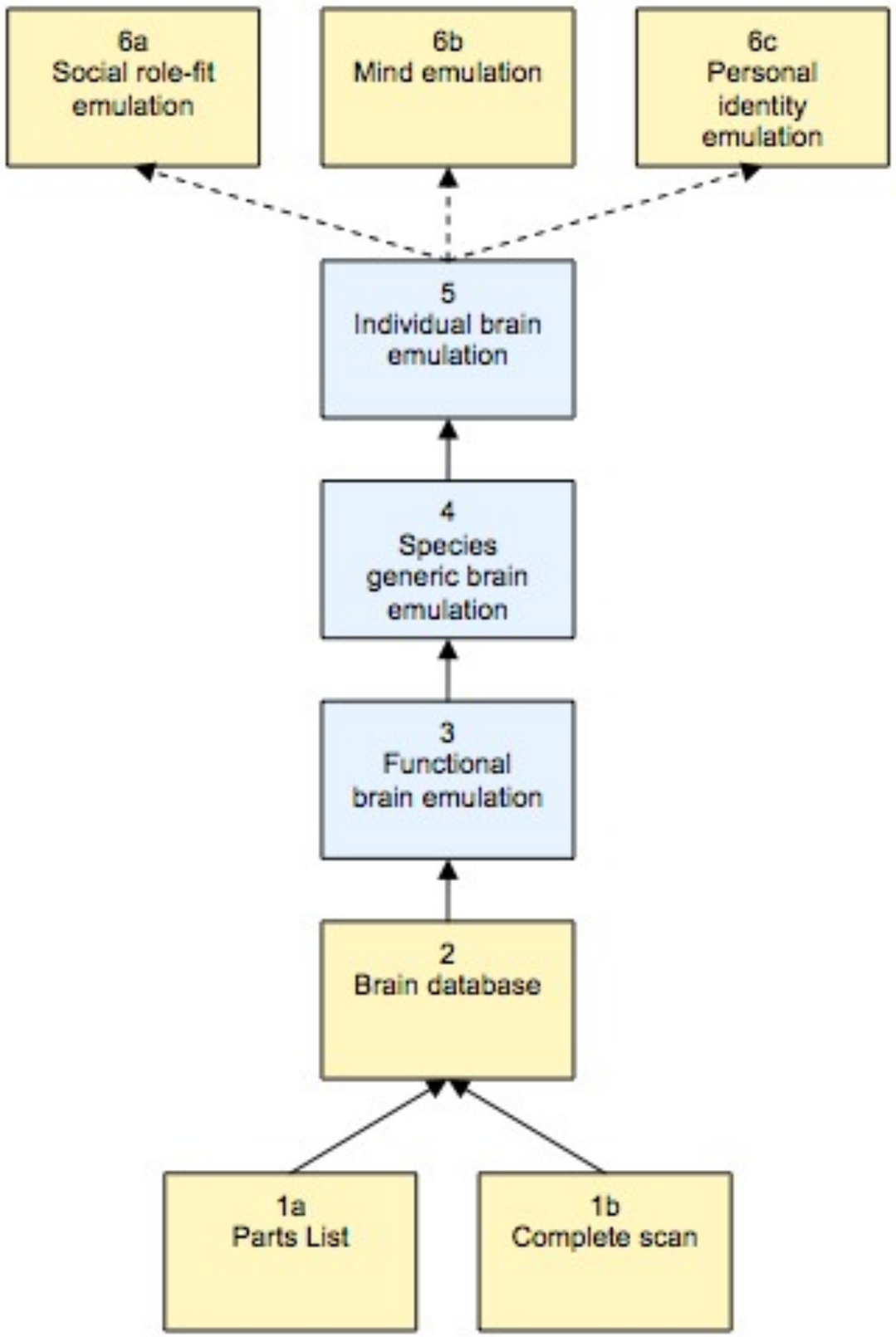
# Virtual

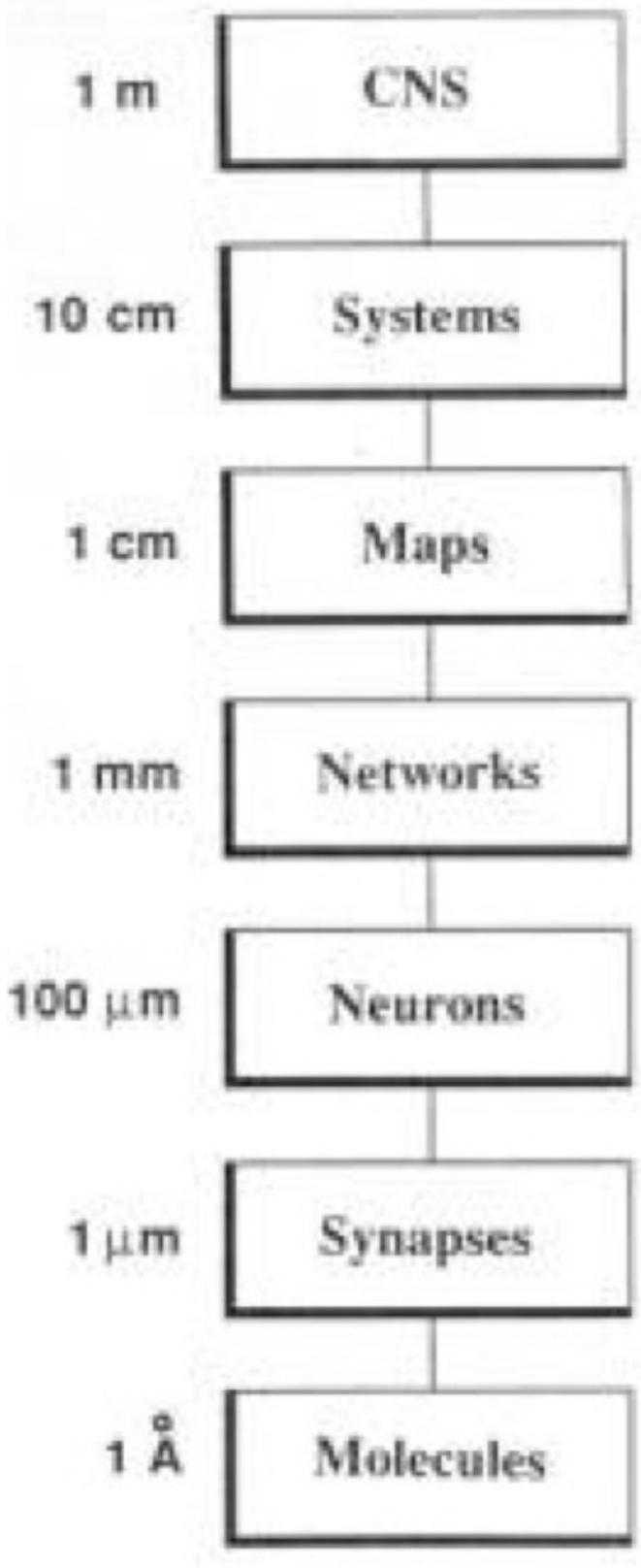



# Robotic

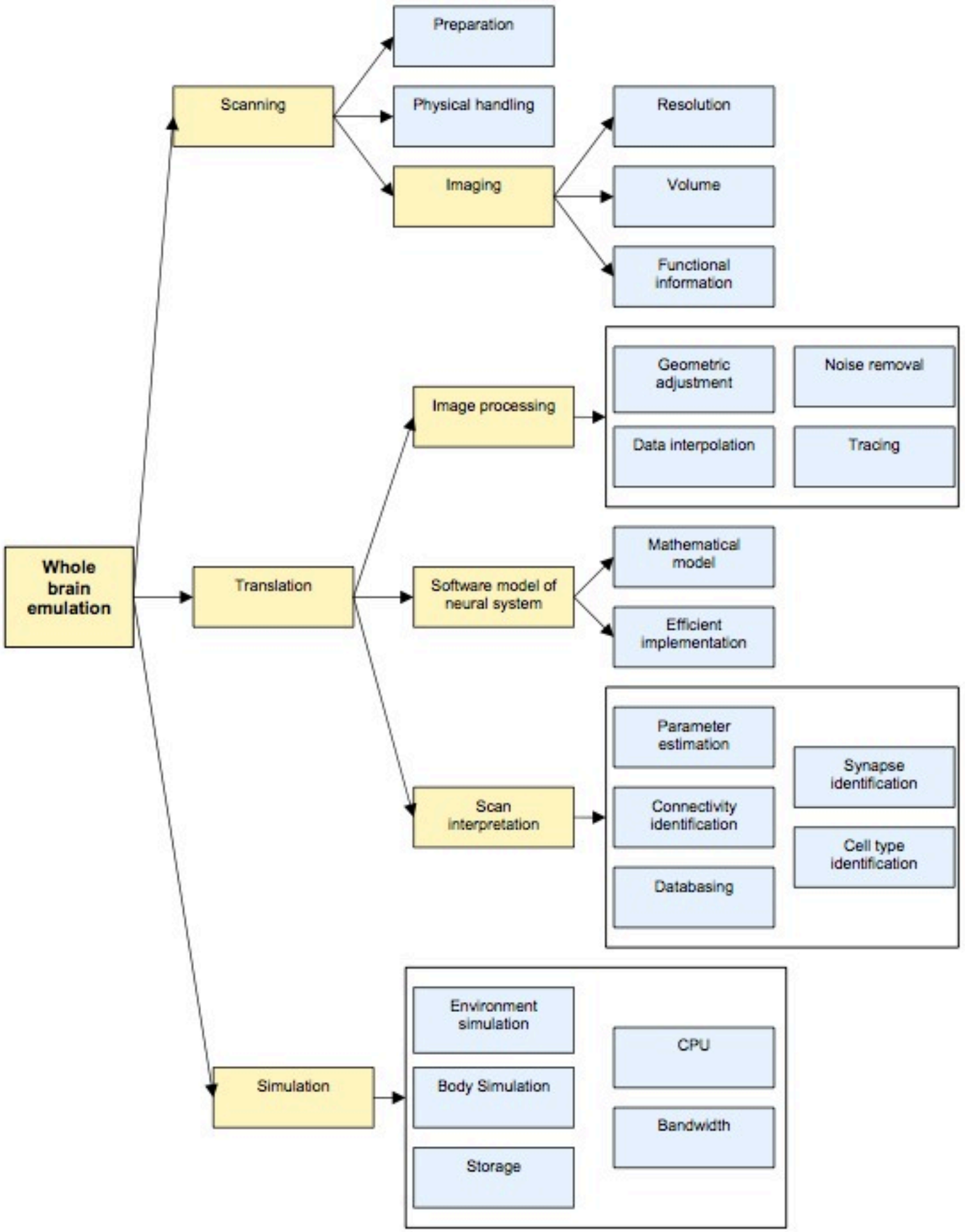


# Levels of emulation and success criteria

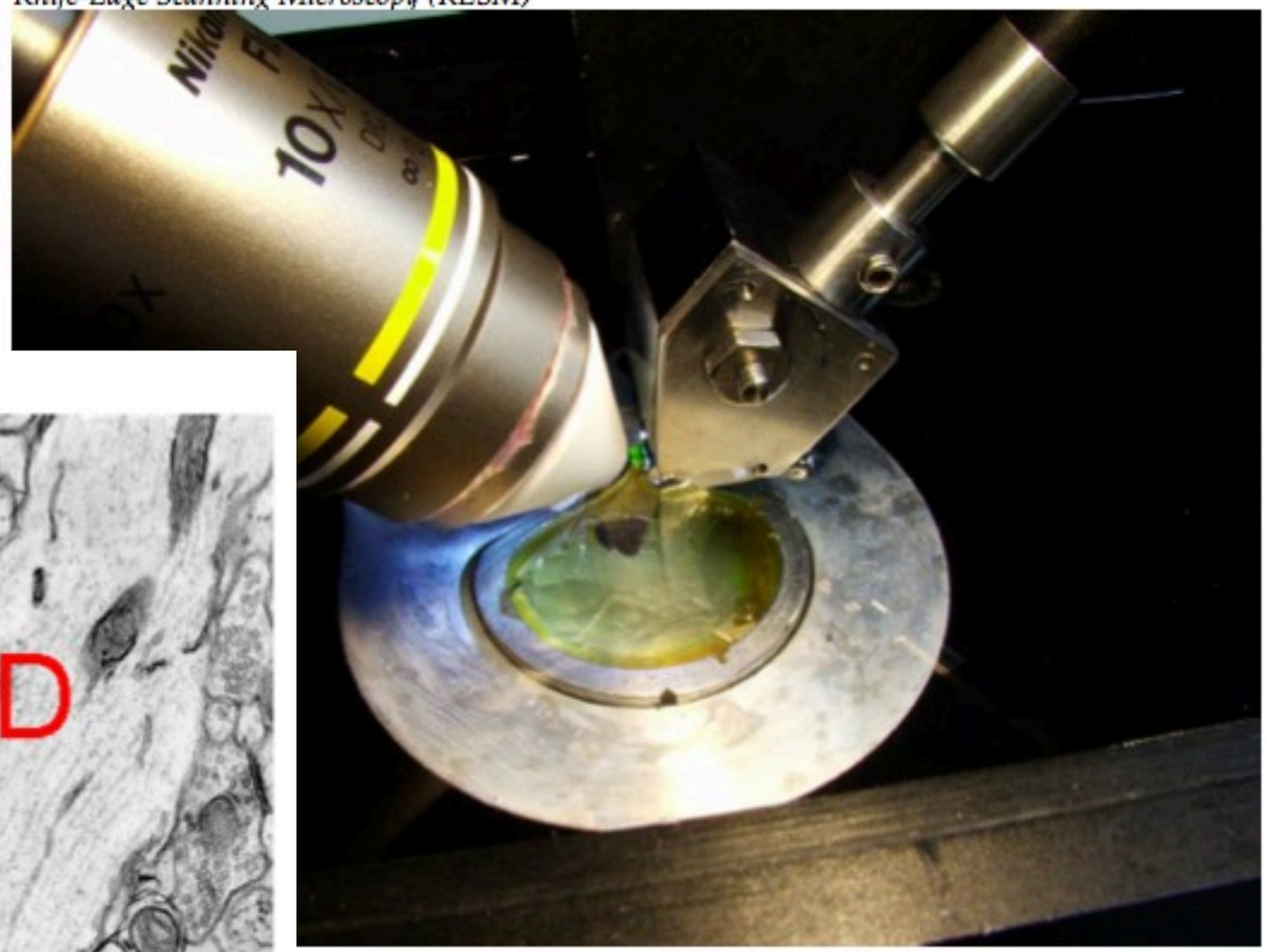



1 m
CNS
10 cm
Systems
1 cm
Maps
1 mm
Networks
100 μm
Neurons
1 μm
Synapses
1 Å
Molecules

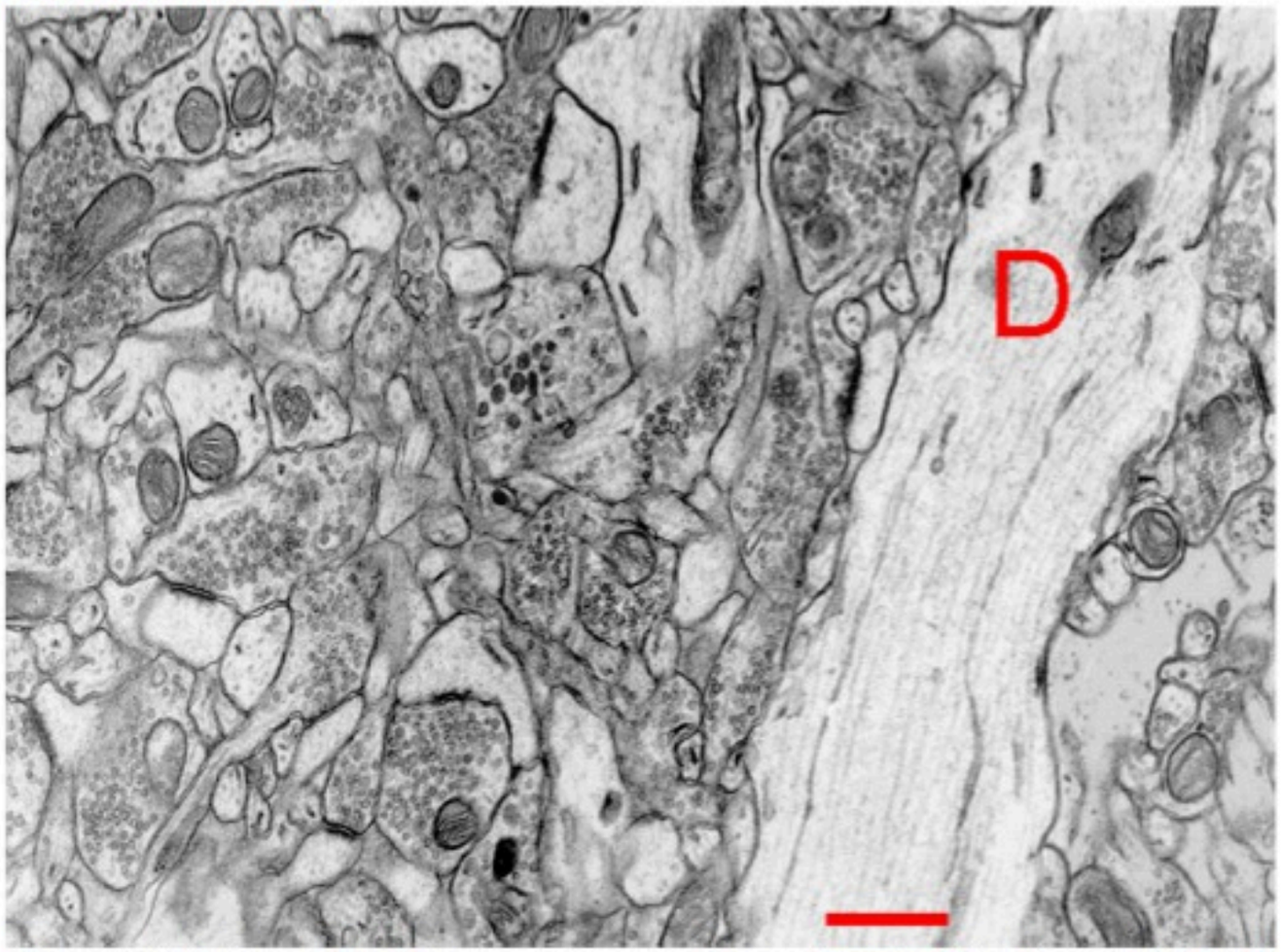
| Level | | |
|---|---|---|
| 1 | Computational module | "Classic AI", high level representations of information and information processing. |
| 2 | Brain region connectivity | Each area represents a functional module, connected to others according to a (species universal) "connectome" (Sporns, Tononi et al., 2005). |
| 3 | Analog network population model | Neurons populations and their connectivity. Activity and states of neurons or groups of neurons are represented as their time-averages. This is similar to connectionist models using ANNs, rate-model neural simulations and cascade models. |
| 4 | Spiking neural network | As above, plus firing properties, firing state and dynamical synaptic states. Integrate and fire models, reduced single compartment models (but also some minicolumn models, e.g. (Johansson and Lansner, 2007)). |
| 5 | Electrophysiology | As above, plus membrane states (ion channel types, properties, state), ion concentrations, currents, voltages and modulation states. Compartment model simulations. |
| 6 | Metabolome | As above, plus concentrations of metabolites and neurotransmitters in compartments. |
| 7 | Proteome | As above, plus concentrations of proteins and gene expression levels. |
| 8 | States of protein complexes | As above, plus quaternary protein structure. |
| 9 | Distribution of complexes | As above, plus "locome" information and internal cellular geometry. |
| 10 | Stochastic behaviour of single molecules | As above plus molecule positions, or a molecular mechanics model of the entire brain. |
| 11 | Quantum | Quantum interactions in and between molecules. |


Whole brain emulation
Scanning
Preparation
Physical handling
Imaging
Resolution
Volume
Functional information
Translation
Image processing
Geometric adjustment
Noise removal
Data interpolation
Tracing
Software model of neural system
Mathematical model
Efficient implementation
Scan interpretation
Parameter estimation
Synapse identification
Connectivity identification
Cell type identification
Databasing
Simulation
Environment simulation
Body Simulation
Storage
CPU
Bandwidth

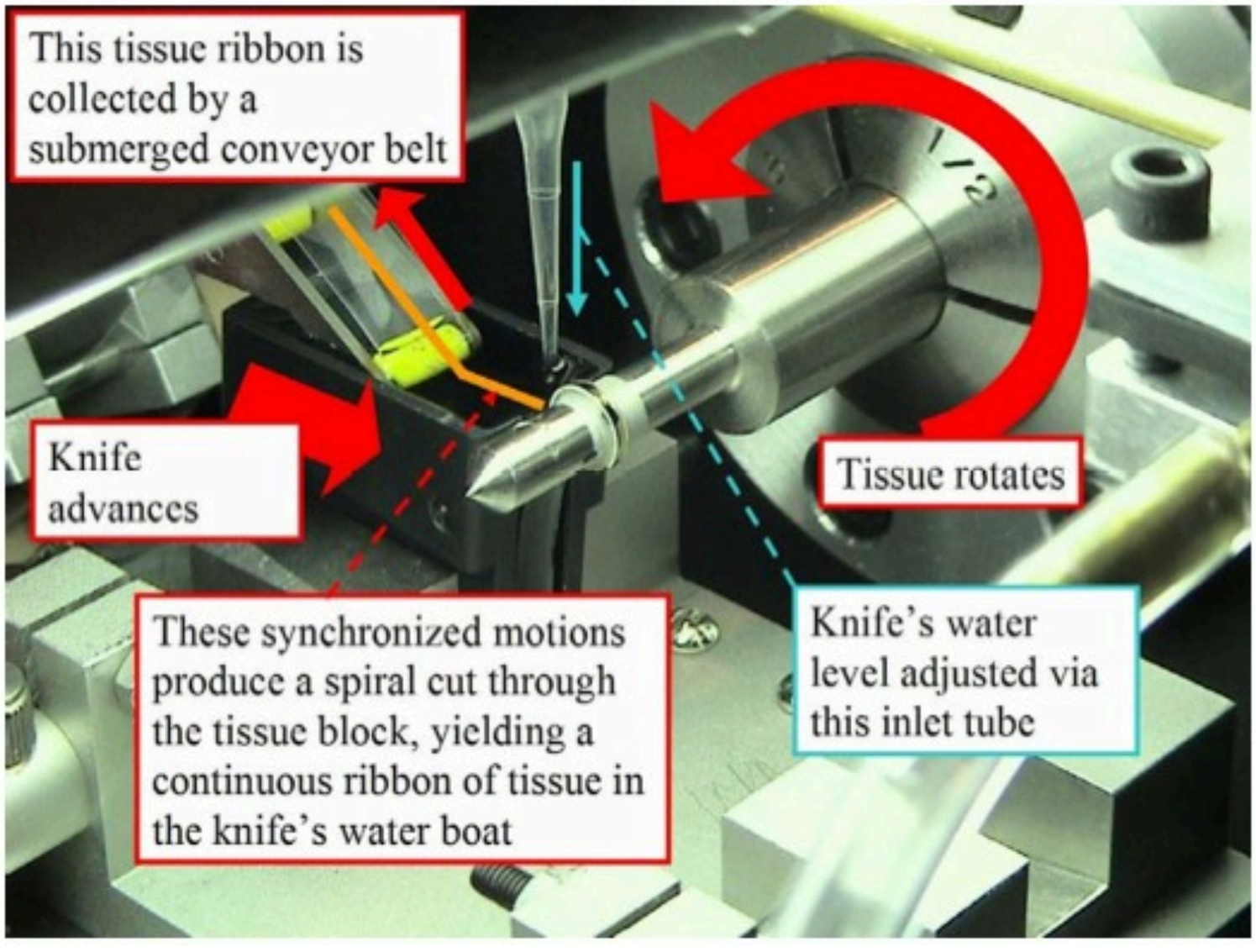
*Knife-Edge Scanning Microscopy (KESM)*

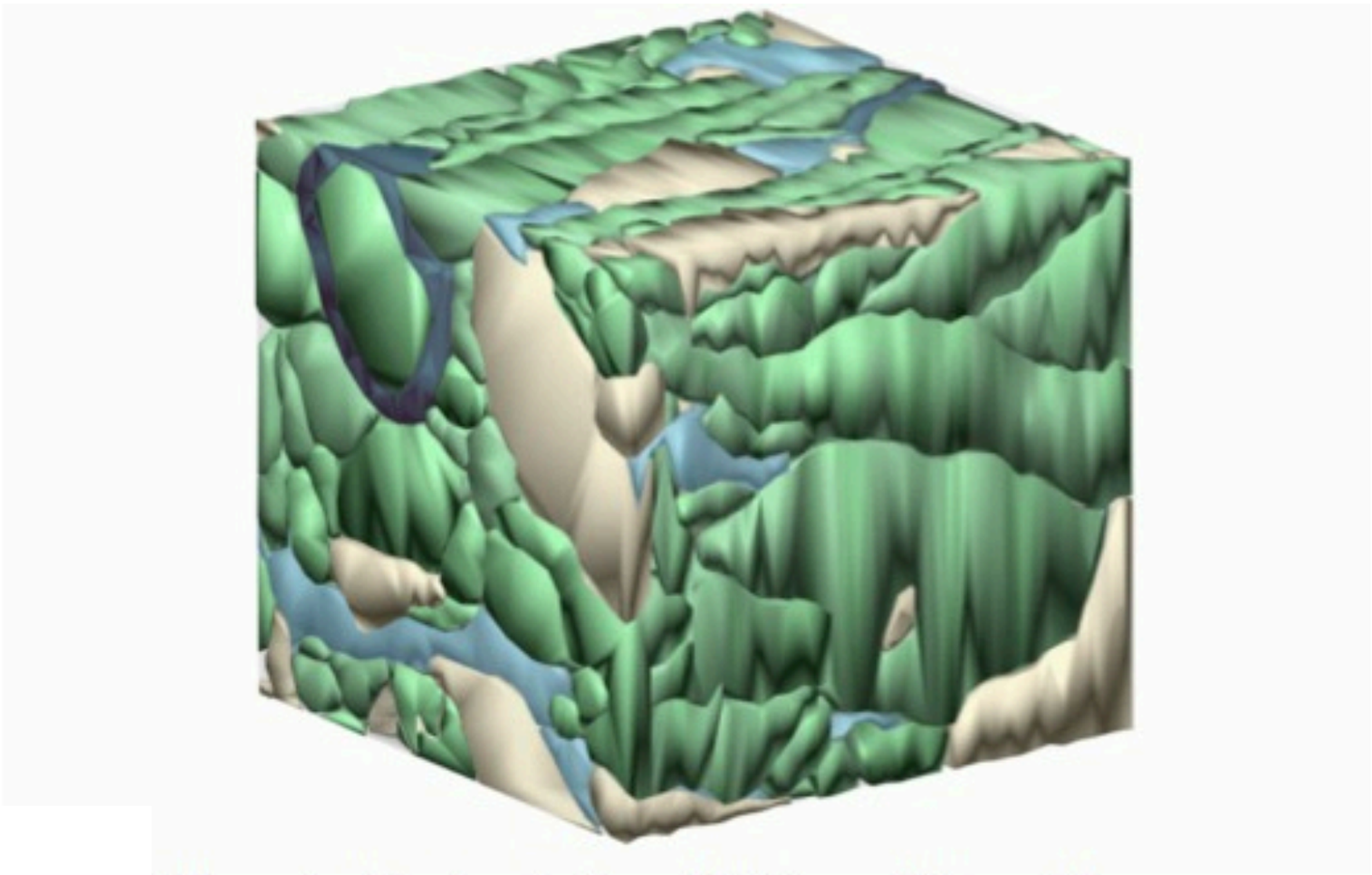


**Electron microscopy**

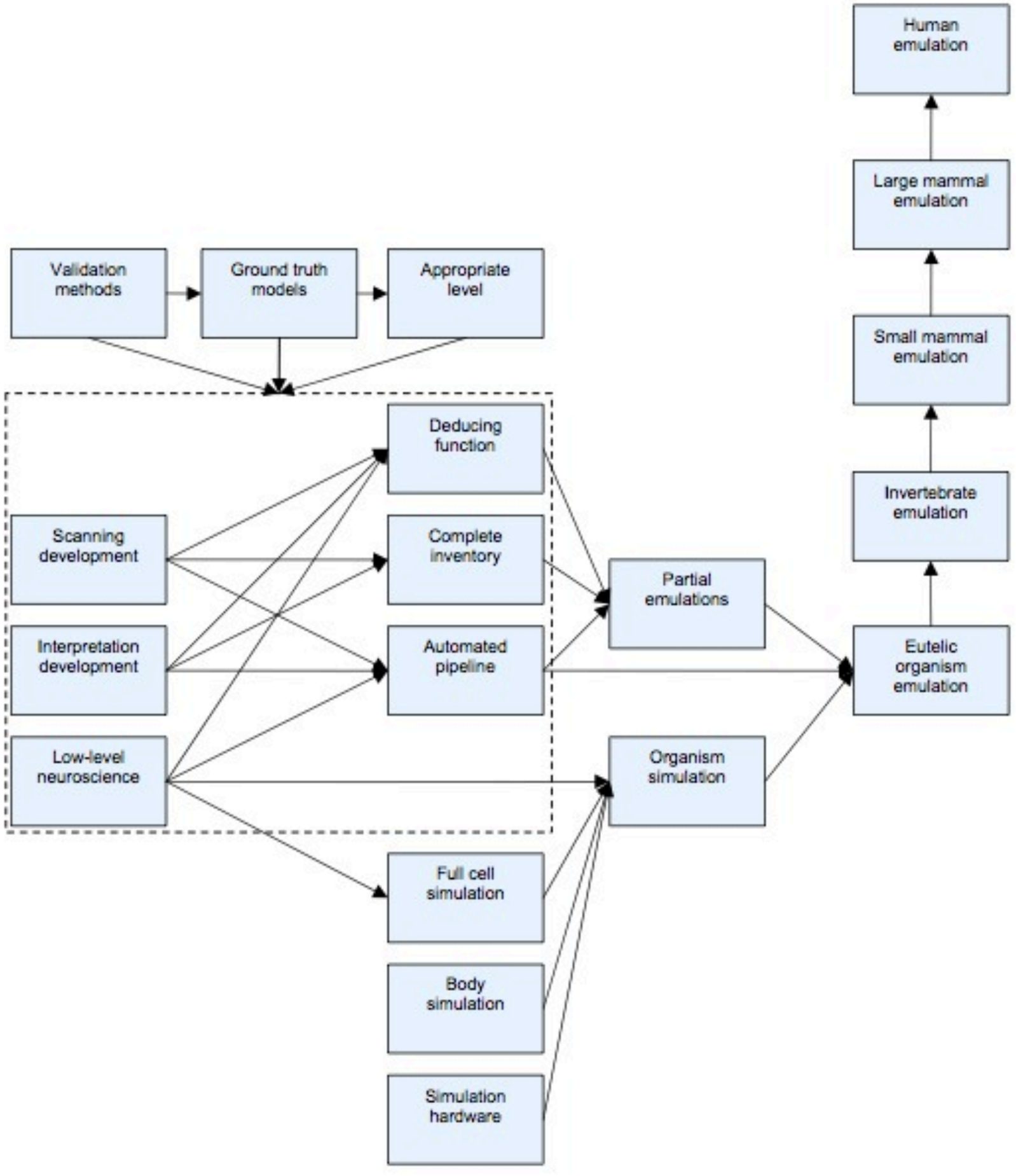


# Automatic Tape-Collecting Lathe Ultramicrotome (ATLUM)

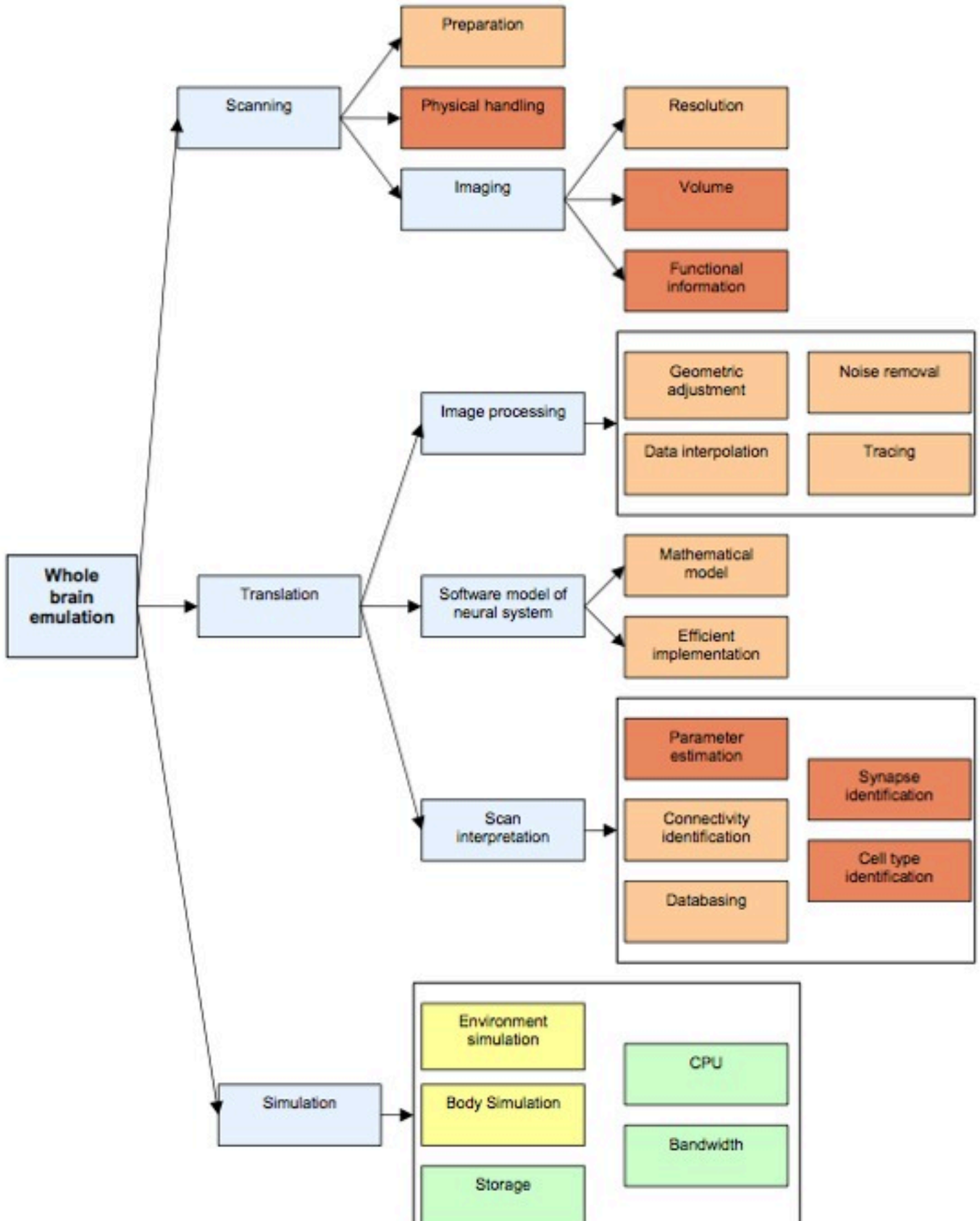




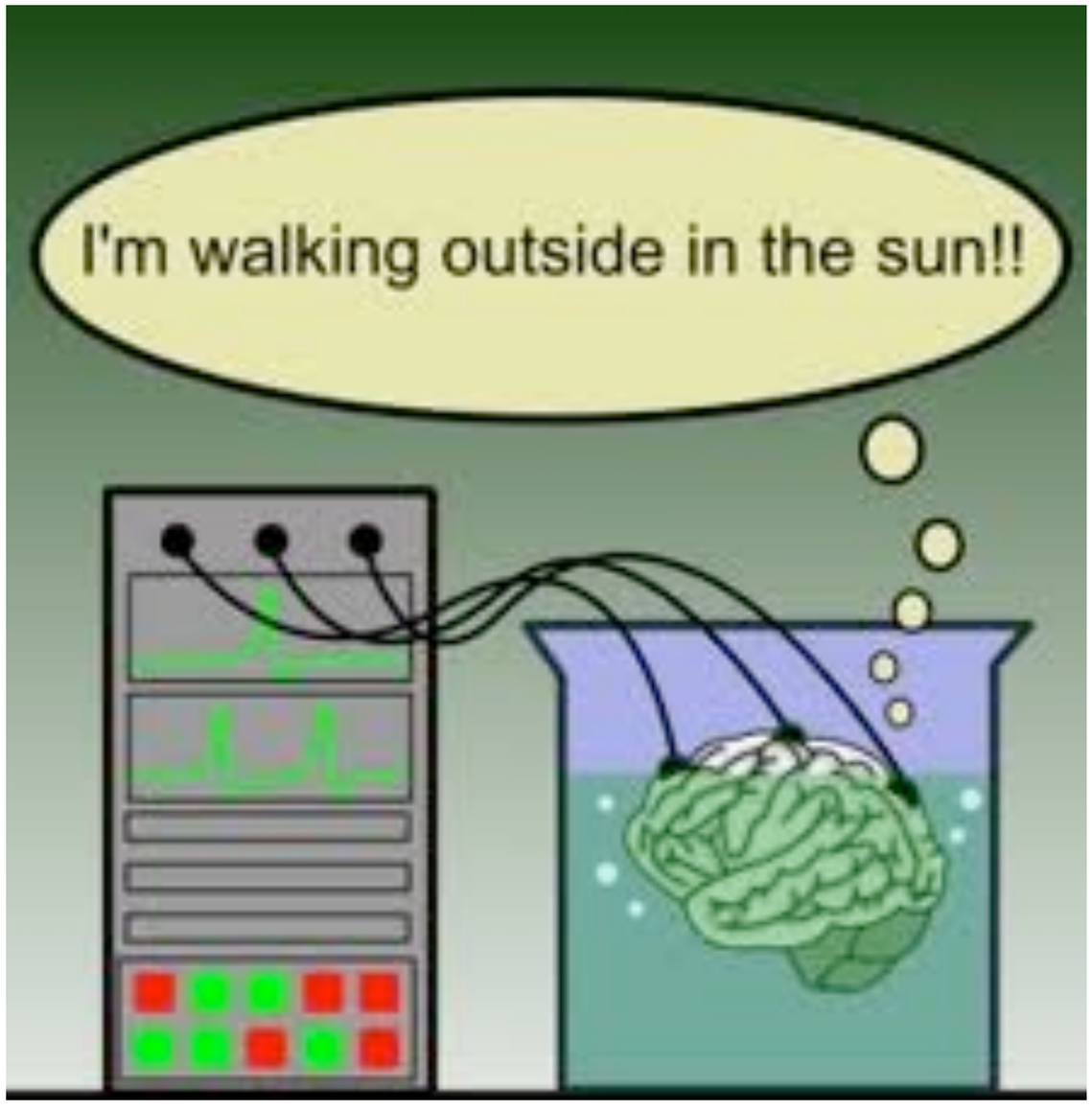
**3D reconstruction of a cube (2 μm side) of neuropil from rat hippocampus. Axons are green, dendrites ochre, astrocytes pale blue, myelin dark blue.**

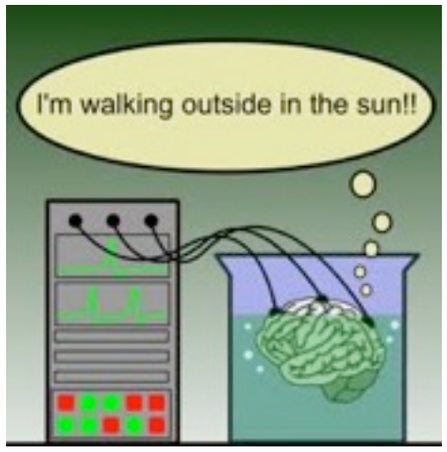

Validation methods
Ground truth models
Appropriate level
Deducing function
Scanning development
Complete inventory
Interpretation development
Automated pipeline
Low-level neuroscience
Partial emulations
Organism simulation
Full cell simulation
Body simulation
Simulation hardware
Human emulation
Large mammal emulation
Small mammal emulation
Invertebrate emulation
Eutelic organism emulation

## Technology drivers



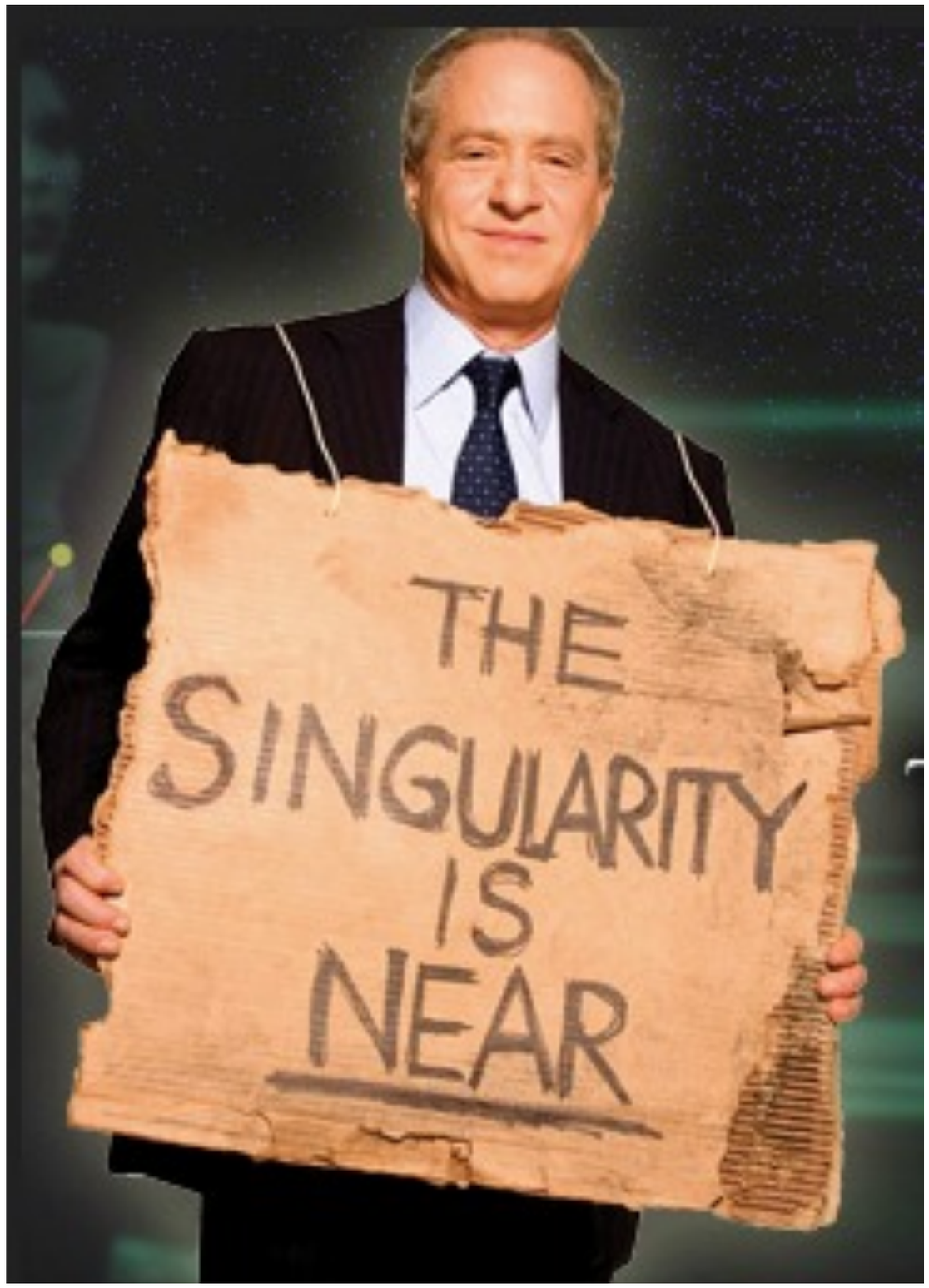
# Virtual Realities


I'm walking outside in the sun!!


I'm walking outside in the sun!!

# Transcension Hypothesis


-Wheze aze they?


THE
SINGULARITY
IS
NEAR