Building Sentient Beings

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Abstract

The current paradigm in artificial intelligence is characterized by eidetic oracles: chatbot question answering systems that ingest internet web sites and curated enterprise data to construct associative memories called Large Language Models (LLMs) and Large Concept Models (LCMs). The next paradigm in artificial intelligence will see the rise of embodied sentient systems employing a diversity of mechanisms, memories, and devices to autonomously perceive and model the world, emotionally regulate themselves, be situationally aware, and engage in long term missions rather than perform simple tasks. The underlying agentic paradigm giving rise to such systems, biological analogs, philosophical underpinnings, and an architectural approach are herein discussed.

Keywords agents, AGI, cognitive architectures, dualism, LLM, mechanism, memory, robot, scheme, sentience.

1. Introduction

The creation of Artificial General Intelligence (AGI) is a telos for many individuals and organizations. An important interim step towards AGI is the development of artificial sentient beings: software and hardware systems that construct internal world models by directly perceiving and manipulating the world as opposed to interacting with and learning from curated consensus knowledge.

1.1 Background

The field of Artificial Intelligence (AI) officially began at the Dartmouth Conference in 1956 and gave rise to chatbots, cognitive architectures, and intelligent agents. The first chatbot was Eliza[1], created in 1966 by Joseph Weizenbaum. Jabberwacky (1998) and Cleverbot (2008) were developed by Rollo Carpenter. Chatbots became more serious with the advent of the general question answering system Deep QA, later known as IBM Watson[2], developed in 2011 to play the game Jeopardy! The study of cognitive architectures begins at the Dartmouth Conference and continues today with numerous exemplar systems such as SOAR[3], Prodigy[4], ACT-R[5], OpenCog[6], ICOM[7], and the Piagetian Modeler[8] among many others. From cognitive architectures came less rigorous and more specialized software agents.

2. Agents

A software agent is a computer program that performs a simple or complex task. Software agents may send messages to other agents, other software systems, or to human end users during the performance of their task. Whereas software agents send messages to each other, biological agents send signals to each other, processing those signals internally.

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2.1 Artificial Agents

The agentic paradigm began in the 1990s with the creation of intelligent agents: autonomous software that did useful things. In 1994 Oren Etzioni and Daniel Weld invented Softbots[9]—programs that used web user interfaces to perform complex internet tasks for humans. Momentum gained in the intelligent agent era with the formation of The Foundation for Intelligent Physical Agents (FIPA)[10] in 1996. The FIPA group produced the Agent Communication Language protocols (ACL) in 1996, and members of FIPA created the Java Agent Development Environment (JADE)[11] in 1998. FIPA disbanded in 2005, and the IEEE formed the FIPA Standards committee which continues today.

Associative memories called neural networks became the dominant research paradigm in 2009 with their success in image classification and automated game playing. By 2017 neural network research yielded Large Language Models (LLMs)[12] and later, Large Concept Models (LCMs)[13] which are created by crawling internet web sites and ingesting curated enterprise data. In 2025, a new renaissance in intelligent agent research unified associative memories (LLMs and LCMs), chatbots, and softbots to create superior question answering systems called "eidetic oracles"—a neologism combining eidetic systems which recall information accurately (often to a photographic level of detail) and oracles who in ancient times provided sagacious advice to inquirers. Despite producing erratic results at times, eidetic oracles are the present state of the art in artificial agents.

2.2 Biological Agents

In biology, agency occurs at a number of levels. Blumberg[14, 15] views the brain and its constituents as self-organizing biological agents (Figure 1). Each agent works coopetitively with peer agents at various levels of scale, from molecular to that of entire brain regions (Figure 2). Biological agents receive afferent signals from both the milieu and other peer agents, transmit internal signals to themselves (often "computing" a response), and send efferent signals to peers or the milieu.

Blumberg states the concept of scale—including molecular, temporal, spatial, and volumetric dimensions—is central to this framework since systems move toward equilibrium through iterative local interactions. At the molecular scale, proteins and receptors are molecular agents that change their conformations in response to biochemical signals, thereby regulating cellular excitability.

At the micro-scale individual cells—including neurons, glia, and immune cells—act as autonomous mini-computers through processes like cellular oscillation and coincidence detection. Cellular agents such as neurons employ mechanisms such as proteins, receptors, ion channels, and local field potentials along pathways that include electrical, chemical, magnetic, and even protein spin-specific signals to fire in patterned rhythms that encode information. Glia and immune cells modulate the extracellular environment of neurons to support healthy neural functioning. At this level, molecular and synaptic incoming events generate small changes in output signal patterns called "phase wave differentials", which accumulate in and begin to shape both the timing and the likelihood of neuronal firing.

Ensemble agents at mesoscale (or "network level") include local neural assemblies, edge communities, cortical columns, and larger groupings such as hypercolumns and rich clubs. These ensembles process incoming stimuli as semi-autonomous units and coordinate to produce coherent sensory and cognitive experiences. For example, cortical columns function as an oscillating group of cells, reinforcing the idea that every agent, whether molecular, cellular or ensemble, contributes to the overall structure of cognition. The mesoscale ensemble agents combine and refine the phase wave differentials originating at the micro-scale, effectively magnifying small differences until they manifest as meaningful oscillatory patterns that drive cognition and behavior. In this layer signals continually loop through subcortical hubs and cortical layers in re-entrant feedback circuits. Micro-level events interact across regional assemblies and interplay among structures like the thalamus, hippocampus, and cortex, linking them into coherent mesoscopic dynamics. Cellular and ensemble agents perform oscillatory communication. Both structural (physical) and functional (signal based) connectivity among ensemble agents (e.g., cortical columns) support and unite disparate regions of the brain, ensuring that signaling patterns emerging in different areas merge into a comprehensive consistent representation. Messages are signals: oscillations that can manifest as soliton waves containing phase wave differential rhythms.

At the macroscale, the focus shifts to global brainwave functions and consciousness, where large-scale rhythms such as alpha, beta, and gamma waves, along with top-down and bottom-up gating, merge local and regional signals into unified cognitive states. Phase wave differentials that began at the cellular level ultimately propagate across the entire cortex, bonding disparate regions into a single oscillatory framework that can give rise to conscious awareness.[16]

3. Beings

Beings have a body and are situated in a world. The requirements and choices surrounding the construction of sentient artificial beings can be understood by comparing and contrasting them to biological beings. A cursory exploration of what it means to exist as a being now follows.

3.1 Biological Beings

You are a biological being. You have a body, and a brain, and you may have a mind. In philosophy, Dualism is the belief that the mind and the body are separate and distinct. Non-Dualists believe that only conscious awareness exists: to exist means to stand apart from that which does not exist. The Non-Dualists believe you are conscious awareness, and you exist here and now. This means you are localized here: you can never go there, because once you go there, there becomes here, and here you are again. This also means you exist now: you exist only in the present moment, in the eternal now. The past and the future are merely imaginings.

Non-Dualists believe that through the medium of thinking and perceiving you as conscious awareness can construct and utilize time and space to localize your experiences. For example, in dreaming your conscious awareness imagines places and localizes itself to those places within the dream world, meanwhile your actual physical body is localized elsewhere in [what we call] the real world. While Non-Dualists believe conscious awareness modulated by thinking and perceiving creates time and space, others disagree and believe space and time existed well before our individual existence.

Finally, Non-Dualists believe that conscious awareness is aware of itself. You are aware of yourself. To be self-aware creates a necessary subject-object duality, with conscious awareness being both the subject and the object. Once this duality exists, then there can be experiencers and experiences, perceivers and perceptions, thinkers and thoughts. Artificial beings require the subject-object duality to perceive the real world; therefore, Dualism is a requirement for artificial beings.

3.2 Artificial Beings

Artificial beings have a brain which is hardware, a mind which is software executing on the hardware, and a body which may be either hardware or software. Artificial brains may reside within the body or be separated from the body. Artificial beings exist in a world. The brain, mind, and body of an artificial being may exist together in the real world, or the brain and mind may exist in the real world while the body exists in a virtual world (Figure 3). With artificial beings, the relationship between the mind and the body has even more options. An individual mind is a single mind that controls a single body. A unity mind is a single mind that controls multiple bodies. Multiple minds can jointly control a single body; and a "hive" mind coordinates multiple minds and multiple bodies (Figure 4). The best configuration from the perspective of a sentient being creator is an individual mind since it simplifies monitoring, tracing, and explaining the artificial being's perceptions, thoughts, and actions. A sentient artificial being is embodied, perceiving, emotional, situationally aware, and autonomous.

3.2.1 Embodiment

An artificial being should preferably have a real body in the real world. This means one or more devices such as a robot or even a cell phone. A humanoid robot body would be ideal for navigating the civilized world since human civilization was built to suit a human bipedal body.

3.2.2 Artificial Minds

Given an individual brain, mind, and body configuration, a generic artificial mind (Figure 5) can be comprised of components, design patterns, software mechanisms and a memory (Figure 6a). Components for memory, observation (adding sensations to memory), coordination (adding inferences to memory), reflection (altering the system's behavior), and consolidation (compacting the memory) can be part of the overall artificial mind architecture along with design patterns which decompose the components into sets of proactive and reactive mechanisms.

3.2.2.1 Mechanisms

The components of the mind divide the labor of the mind into design patterns[17]. Each design pattern is comprised of software mechanisms that utilize areas of memory (Figures 6b, 6c). There are two types of mechanisms, proactive and reactive. Reactive mechanisms are implemented as services and proactive mechanisms are implemented as simple agents.

(service *url handler***)**	; a reactive mechanism
(agent *job url handler delay***)**	; a proactive mechanism

A service is a function having a URL to receive and enqueue messages and a message handler function to process the messages. A simple agent has a default job which is a function, a delay interval to rest between jobs, a URL to receive and enqueue messages, and a message handler function to process the messages. The mechanisms are rules for perceiving the world and updating the memory.

3.2.2.2 Memory

The memory of the proposed artificial mind is an adaptive world model called a Totality (Figure 7). It contains areas for perception, imagination, ontology, association, and activation (Figure 8). The memory may be implemented as a distributed, consolidated, or clustered relational database (Figure 9).

Associative memory within the Totality is used primarily in the process of observation to index and store new experiences. There are different kinds of experiences: interocepts (i.e. somatic urges), propriocepts (i.e., action feedback or kinesthetic sensations), and percepts (i.e., external sensations). During observation experiences emanating from a device are routed to a perceiver mechanism. Feature detector mechanisms identify traits (tokens in LLM parlance) of the observed experiences. The trait sets (embeddings) are matched against associative memory, and either a known experience is retrieved, or the new experience and its traits are stored. The experience and its traits are then activated (Table 1). Associative memory is therefore the concordance of experience. Actions and reasons (justifications) are also stored in associative memory by problem solving and reasoning mechanisms.

The process of observation also uses perceptual memory to store or recognize perceptual elements such as sounds, phonemes, shapes, objects, icons, geons, scenes, and so forth. Messages received by the perceiving mechanisms are parsed and added to a lexicon in perceptual memory. Percepts are maintained in perceptual memory and are eventually grounded (linked to triggers) using the current situational context. Grounding enables future recall and replay of percepts, especially video or audio clips whenever triggering conditions are activated and default mode daydreaming is engaged. Scene analysis mechanisms detect image schemas[18] storing them in perceptual memory as well. Image schemas capture the arrangement and grouping of visual elements.

Ontological memory organizes the experience of the artificial being into a semantic classification heterarchy—a knowledge graph network having multiple apices. The ontological memory unit is called a Piagetian scheme or Neural Proposition[19] which simultaneously bears resemblance to a neuron and a logical proposition (Figures 10, 11, 12). The Piagetian scheme structure has a reifier (a 128 bit signed integer which uniquely identifies the scheme, positive reifiers represent affirmations while negative reifiers represent negations), a relation indicating the role of the scheme, an argument list representing inputs to the relation, and a referent list representing outputs of the relation. A schema is a hierarchy of schemes. Jean Piaget proposed that mental structures called schemas[20,21,22] exist in the human mind. He believed that these structures are continually created and modified by various mental mechanisms from birth until death. These structures hold correspondences to things in the real world. In an artificial being, schemes are the units of ontological memory. Furthermore, the ontology is initially primed using a set of bootstrap scheme relations (Figure 13). During the operation of the artificial being mechanisms create, read, update, and delete schemes. For example, solver and reasoner mechanisms create and utilize action and reason schemas during mental coordination (Figure 14).

Working memory is the memory used by mechanisms to complete their jobs. In contrast, activative memory partitions the ontology into relevant and irrelevant knowledge. Activative memory uses time stamps and decay over time to discern relevant active schemes from irrelevant inactive schemes. Additionally, activative memory is organized into a Euclidean space using coordinate glue to position schemes, much in the same manner glial cells in the brain position neurons within the three dimensional space of the brain. In the Euclidean space, relevant schemes can be activated via their connectivity or via their proximity. Activative memory is also compartmentalized into realities and viewpoints (akin to microtheories[23]). Activation flows from scheme to scheme within activative memory according to prescribed coalescence and dispersion rules.

Imaginative memory is comprised of compartmentalized mental canvases on which specialized mechanisms create two or three dimensional animations called "dreams". A canvas has a collection of elements called a taxis (Greek "*tak•sis*" meaning "arrangement") which binds together a perspective camera angle, multimedia and animation resources, and meshes to be rendered. The taxis in imaginative memory serves a similar purpose to image schemas in perceptual memory. Objects from perception can be used to construct scenes and animations in imaginative memory. Entirely new objects and scenes can also be created in imaginative memory.

3.2.3 Emotion

Emotion in a sentient artificial being can be based on a simple notion of valence, the measure of good or bad (positive or negative feeling), and arousal, the measure of excitement or indifference. This emotion can be ascribed both to the sentient being as well as to schemes in the mind of the being. Robert Plutchik's Wheel of Emotions[24] has eight axes and is implemented by the Independent Core Observer Model (ICOM) cognitive architecture. The coping design pattern enables a cognitive system to regulate itself by reprioritizing objectives meeting the constantly changing needs of the system, thereby overcoming impasses and alleviating frustration.

3.2.4 Awareness

Although no one can be sure that artificial beings will have conscious awareness, creators of artificial sentient beings can engineer situational awareness. Situational awareness is the ability to discern and predict the elements in the immediate vicinity of the being, their trajectories, actions, intentions and future states. The artificial being begins life with a tabula rasa awareness of the world. Through its endowed perceptual mechanisms the artificial being is able to detect features of the environment which are matched or constructed and activated in memory. Through extended interaction with the world, observation and coordination mechanisms create schemes (i.e., “distinctions” or “conditions”) as mental correlates of world features. These distinctions become part of the artificial being’s ontology. Associations and categorizations add to the ontology as clusters of features become objects and beings. As the artificial being gains experience in perceiving, thinking, and acting upon the world, mechanisms that make and test predictions can be employed. Distinctions for the self and other beings are conjectured to arise within the awareness of the being (Figure 16) and need not be explicitly engineered. Mechanisms that create stories to explain phenomena in the world and mechanisms that learn lessons from experience add even more distinctions to the ontology and situational awareness.

3.2.5 Intelligence

The sentient being’s level of intelligence should be repeatedly assessed at intervals by trained psychologists. Strategies to assess and track the development from general awareness to object permanence, to the grasp of consciousness, to differentiation of the self from others, to theory of mind (knowing the mental content and intentions of others), to concrete and formal mental operations, to the formation of the Jungian ego and shadow, and to other cognitive milestones will be essential (Figure 17). The sentient being’s intelligence can be incrementally refined by adding or removing mechanisms and memory between assessments. The Bailey Scales of Infant Intelligence, Piagetian Milestones, as well as the Cattell-Horn-Carrol model of intelligence are all good tools for intelligence assessment.

3.2.6 Autonomy

Because they are autonomous, sentient artificial beings are not task oriented, but mission oriented. There should be no obvious way to inject goals into a sentient being since their interaction with the world should be entirely through perception. Sentient beings will participate in long time horizon objectives, or “missions,” to which they agree to be assigned or invent themselves. As such, the purpose of a sentient being in life is therefore very important. We can envision many roles for artificial beings: from artisans, that continually acquire and improve new skills, to scouts designed to perform reconnaissance. These autonomous beings will undoubtedly have to balance their commitment to their own self-preservation with the requirements of the missions they perform (Table 2).

4. Future Work

Sentient beings—systems that build world models from direct perception—represent the next stop on the road to artificial general intelligence. Comparisons to biological beings, and a general architecture for them were presented. Progress of the prototype system, intelligence assessments, and refinement of learning mechanisms will be reported in subsequent publications.

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Tables

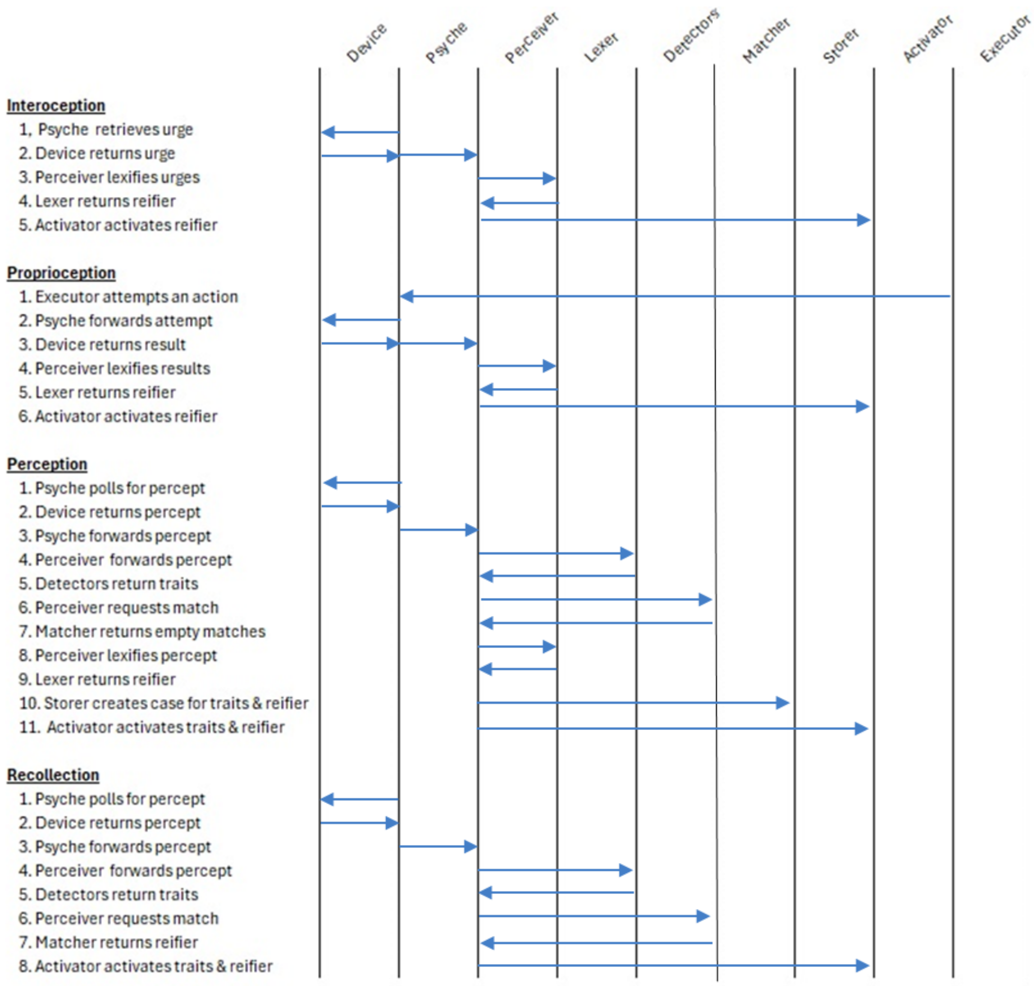


Table 1. Observation Pattern Sequences (simplified).

Kind	Purpose	Commitment		
		Self	Mission	Truth
Chatbot	Entertains people	NONE	NONE	NONE
Softbot	Performs internet tasks	NONE	HIGH	NONE
Oracle	Performs user requests	NONE	MODERATE	NONE
Robot	Performs physical tasks	NONE	HIGH	NONE
Artisan	Learns new skills	SOME	HIGH	HIGH
Explorer	Acquires new knowledge	SOME	HIGH	HIGH
Scientist	Forms and tests hypotheses	MODERATE	MODERATE	HIGH
Soldier	Performs assigned missions	MODERATE	HIGH	HIGH
Scout	Performs reconnaisance	HIGH	MODERATE	HIGH

Table 2. Software, artificial beings, and their commitments.

Figures

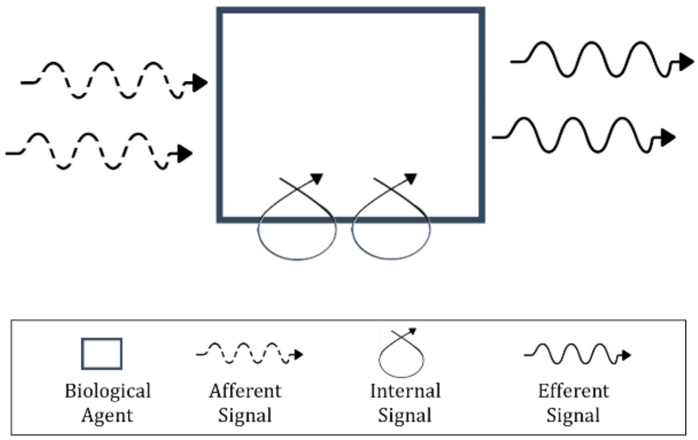


Figure 1. A generic biological agent.

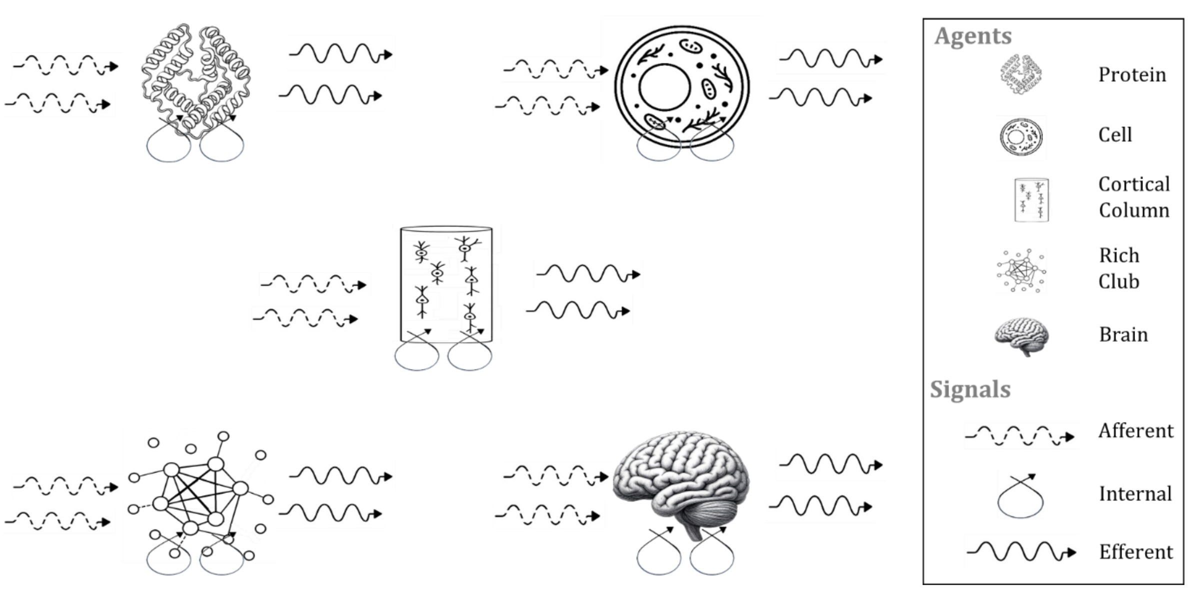


Figure 2. Levels of biological agency.

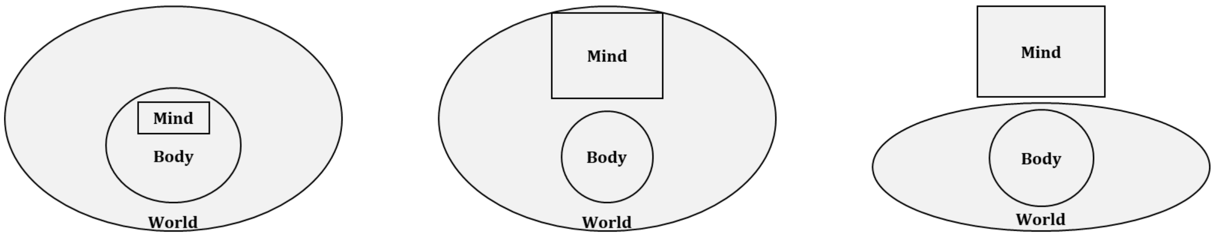


Figure 3. Options for artificial beings.

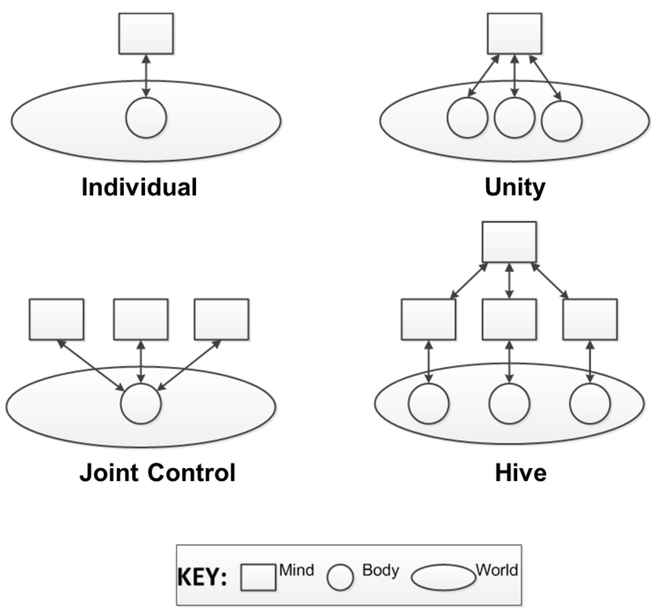


Figure 4. Kinds of artificial beings.

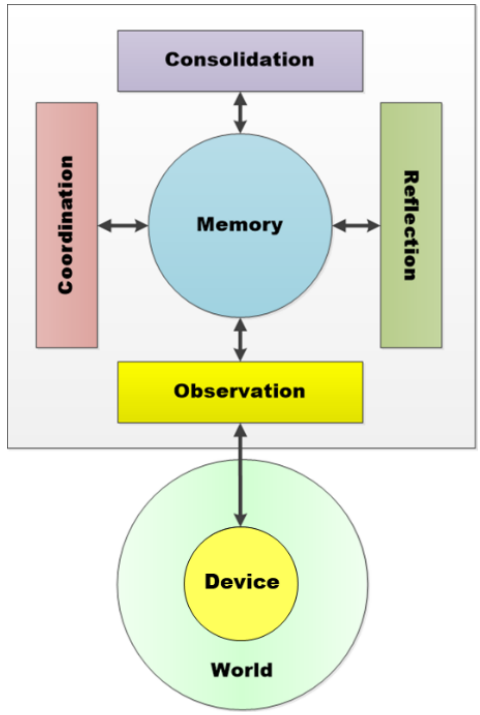


Figure 5. A generic artificial being.

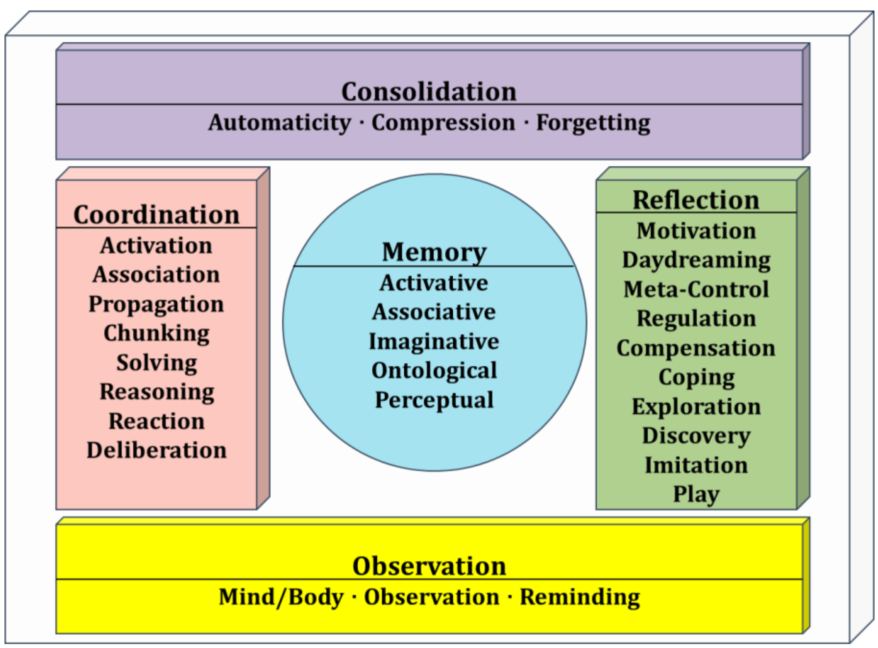
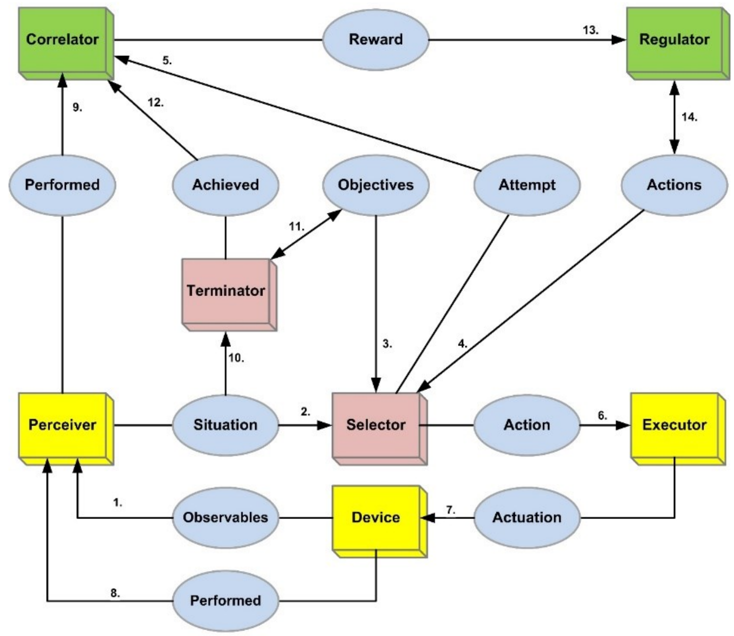
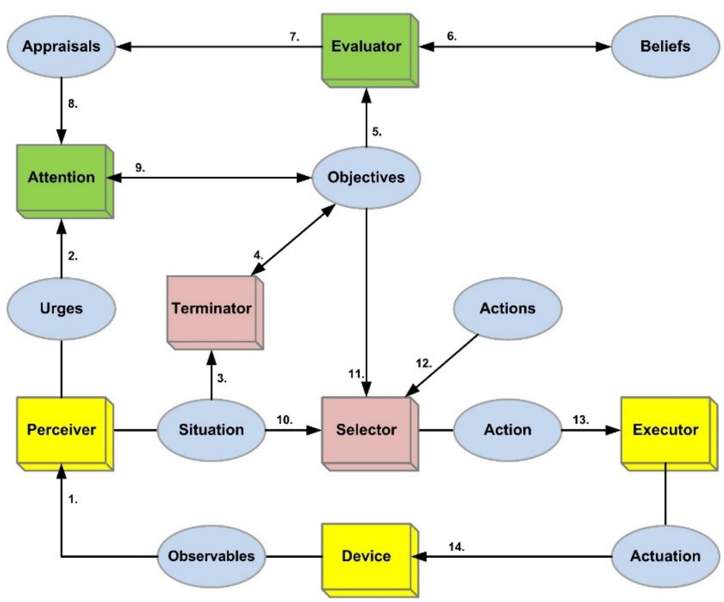


Figure 6a. Decomposition of mind components, design patterns and memory areas.



Device	A device in a real or virtual world
Observables	Percepts, urges, proprioceptions
Perceiver	Updates Observables in memory
Situation	The most recent observables
Selector	Chooses actions to perform
Objectives	Conditions to be attained
Actions	Macro-operators or policies
Attempt	The action tried by the system
Action	The selected action to perform
Executor	Sends actuations to device
Actuation	A device command
Performed	An actuation proprioception
Correlator	Determines reward for attempts
Terminator	Determines if objective achieved
Achieved	Objective attainment signal
Reward	Feedback from an action attempt
Regulator	Reinforces or corrects actions

Figure 6b. The Regulation Design Pattern



Device	A device in a real or virtual world
Observables	Percepts, urges, proprioceptions
Perceiver	Updates Observables in memory
Urges	Homeostatic deltas from device
Situation	The most recent observables
Terminator	Determines if objective achieved
Objectives	Conditions to be attained
Evaluator	Appraises efforts toward objectives
Beliefs	Thoughts about the situation
Appraisals	Feelings about objectives
Attention	Reprioritizes objectives
Selector	Chooses actions to perform
Actions	Macro-operators or policies
Action	The selected action to perform
Executor	Sends actuations to device
Actuation	A device command

Figure 6c. The Coping Design Pattern

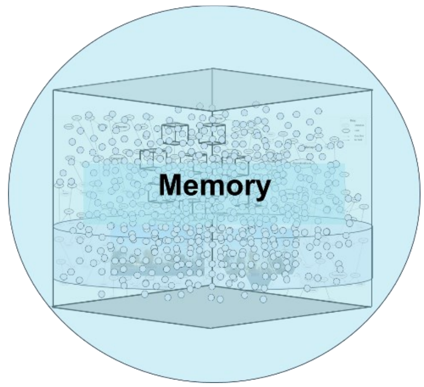


Figure 7. The Totality.

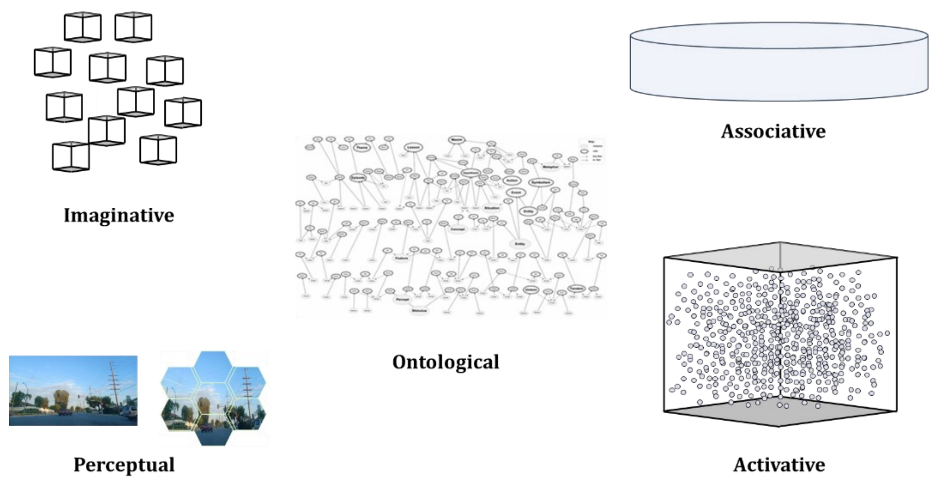


Figure 8. Areas of the Totality.

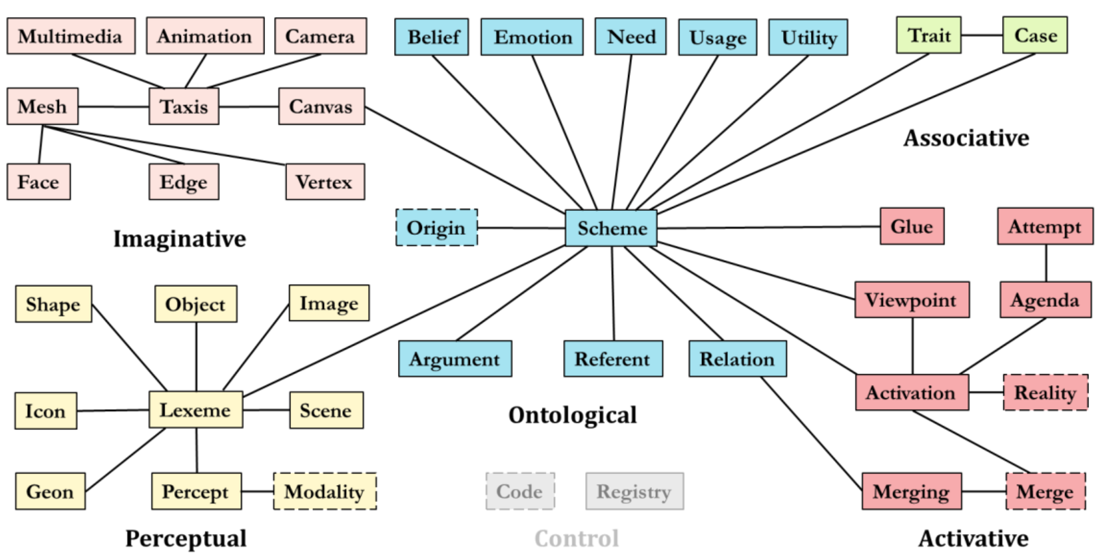


Figure 9. Entity relationships within the Totality.

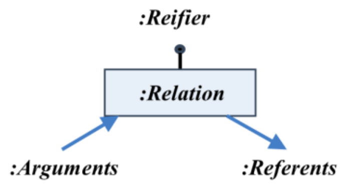
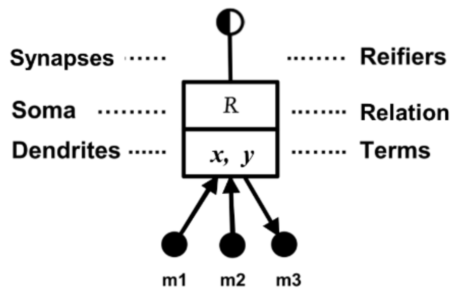


Figure 10. The Piagetian scheme ontological unit.



$$\mathbf{R(m1, m2) = m3}$$

Figure 11. The Neural Proposition.

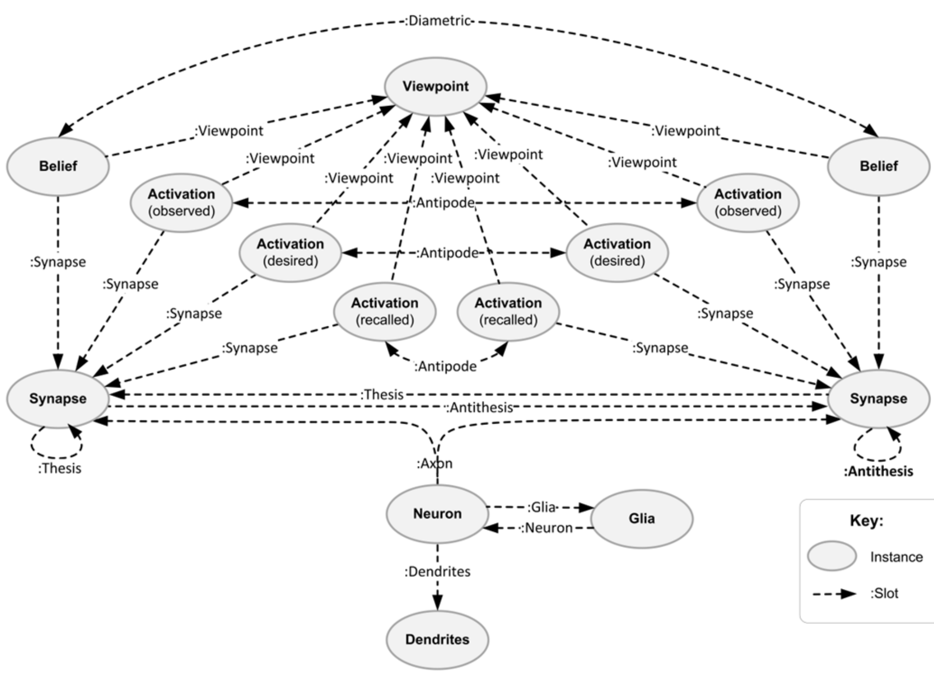
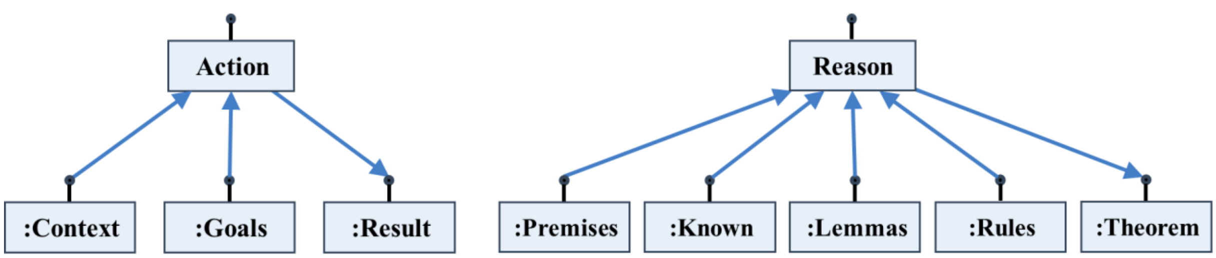


Figure 12. Neuronal view of a scheme within the Totality.

Abstractions	Hypothesis Causes Implies Refuter Sign Symbol Metaphor Event Analogy Entity Situation Statement Objective Believes Desires Intends Episode Story Lesson Frame Actuation Action Operation Reason Utterance Dream Obstacle Contradiction Problem Lacuna Theme Maxim Theory
Structures	Idea Prototype Class Concept
Gates	Category Choice League Ordering Unison Series
Vertical	Different Equivalent Identical Incompatible Similar
Simple	Genus Grounding Member Tandem Slot Swap Symbolism
Images	Above Across Apart Behind Beside Boundary Contact Container Path Together
Observables	Feature Result Percept Urge

Figure 13. Bootstrap scheme relations.



Action	:Context	; the unison* of preconditions
	:Goals	; the series of actions or actuations to perform
	:Result	; the [unison of] postcondition[s]
Reason	:Premises	; the unison of relevant preconditions
	:Known	; the unison of required background assumptions
	:Lemmas	; the unison of necessary (lacunae spanning) reasons
	:Rules	; the series of applied operations (i.e., knowledge transmutations)
	:Theorem	; the [unison of] conclusion[s]

* Unisons are concurrently activated sets. Series are sequentially activated sets

Figure 14. Action and Reason schemas.

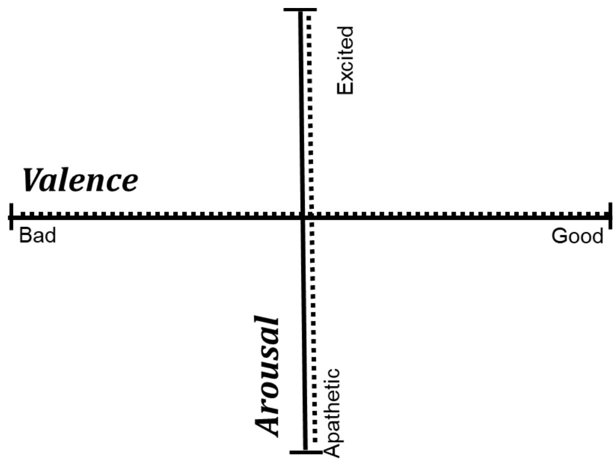


Figure 15. A basic emotional model.

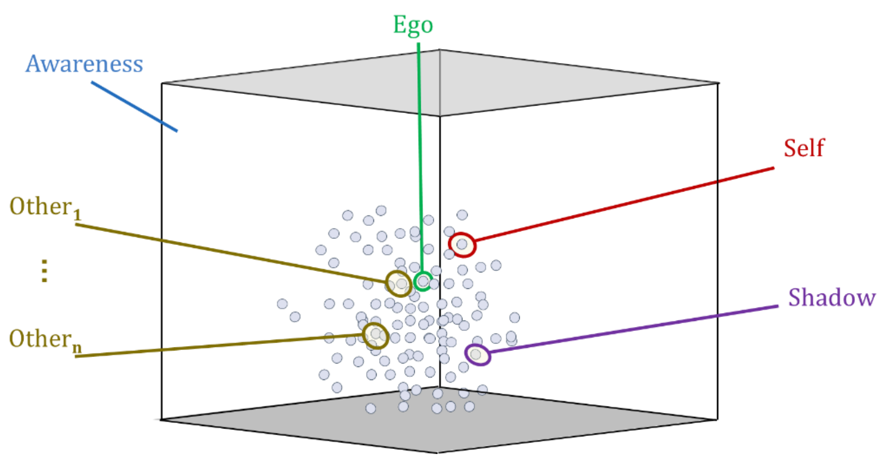


Figure 16. Situational Awareness: evolving from general awareness, to Theory of Mind, to Shadow work.

Awareness	*the initial viewpoint of General Awareness*
Self	*the view from self awareness and self interest*
Other$_{1..i}$	*other perspectives created as needed*
Ego	*the view from consciousness, preferences & responsibility*
Other$_{i+1..k}$	*more perspectives created as needed*
Shadow	*the view from ignorance, aversions & freedom*
Other$_{k+1..n}$	*even more perspectives created as needed*

Figure 17. Levels of Awareness.