A Cognitive Theory of Everything:

The LIDA Technology as an Artificial General Intelligence

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What is general intelligence?

- Machines with human-level, and even superhuman, intelligence
- Generalize their knowledge across different domains
- Reflect on themselves
- Create fundamental innovations and insights

(From the AGIRI web site)
Artificial General Intelligence?

A brain in a vat won’t do
Where to find intelligence?
In an autonomous agent.
What is an *autonomous agent*?

A system embedded in, and part of, an environment, that

- *Senses* its environment
- *Acts* on it
- *Over time*
- In pursuit of its own *agenda*
- So that its actions affect its future sensing
An Agent in its Environment

- The agent senses its environment and acts on it, over time, in pursuit of its own agenda.
- It must have built in sensors, effectors, and drives, or primitive motivators.
Cognition

- Cognition will be the term I use for the endless cycle of deciding what to do next.
- This use is broader than that typically used in psychology, which omits perception & action.
Perception

- **Perception**—assigning meaning to sensory data
- **Meaning** measured as knowing what to do
- **Assignment** can be **bottom-up and/or top-down**
Procedural Memory

- **Procedural memory**—stores a repertoire of tasks, and streams thereof
- Not to be confused with **sensory-motor memory**, which knows how to perform tasks
Episodic Memory

- Episodic memory — content-addressable, associative, memory for events—what, when, where
- Recalled via mental images—visual, auditory, etc
Attention & Action Selection

- **Attention**—a filtering process of bringing to consciousness

- **Action selection**—process of choosing what to do next
Learning

- Perceptual learning of meanings
- Episodic learning of events
- Procedural learning to improve skills or acquire new ones
Artificial General Intelligence

Where to find it?

If you want smart software, copy it after a human.
LIDA

• IDA — a conceptual and computational model of human cognition without learning

• LIDA — Learning IDA
IDA: an Intelligent Distribution Agent

Dialogue with sailors
Read personnel data
Check job requisition lists
Enforce Navy policies
Choose jobs to offer members
Negotiate with them about jobs
LIDA Implements Theories of Cognition

- Situated (embodied) cognition — Varela, Thompson & Roach
- Perceptual symbol systems — Barsalou
- Working memory — Baddeley
- Memory via affordances — Glenberg
- Long-term working memory — Ericsson & Kinstch
- Global workspace theory — Baars
- Cognitive architecture — Sloman
LIDA Cognitive Cycle

• Employs basic modules of cognition
• Employs primary cognitive processes
• A sort of “cognitive atom”
• Higher level cognitive processes utilize multiple cognitive cycles
• Deliberation, volition, problem solving, metacognition, etc
Human Cognitive Cycle Processing

• Hypothesis—Human cognitive processing is via a continuing iteration of Cognitive Cycles
• Duration—Each cognitive cycle takes roughly 200 ms
• Cascading—Several cycles may have parts running simultaneously in parallel
• Seriality—Consciousness maintains serial order and the illusion of continuity
• Start—Cycle may start with action selection instead of perception
Neuroscience Evidence


Multi-cyclic Cognitive Processes

- Deliberation and volition
- Automazation
- Non-routine problem solving
- Metacognition
- Self-awareness
A Domain for an AGI Agent?

• An AGI agent must come with sensors, motivators and effectors, i.e., a domain

• For it to generalize the domain must be broad enough to have several sub-domains
AGI and Learning

• An AGI agent is too much to build
• Hence, an AGI agent must learn
• How?
• To start, best it learns like a human
Some Principles of Human Learning

- There’s no learning from scratch
- We learn what we attend to
- Learning is incremental and continual
- Learning is a generate and test process
- Much of memory is associative and content addressable
Selectionist & Instructionalist Learning

• Selectionist Learning
  – Representations selected for reinforcement from a redundant repertoire

• Instructionalist Learning
  – new representations constructed

• LIDA learns in both modes
An AGI Agent Must

• Initially be copied after humans
• Have a rich and broad domain
• Employ many multi-cyclic processes
• Be capable of both selectionist and instructionalist learning in several modes
Must an AGI Agent …?

- Be functionally conscious?
- Phenomenally conscious?
- Capable of imagining (internal virtual reality)?
- Be implemented with feelings as drives and modulators of learning?
Trends toward AGI

• Developmental Robotics
  – IEEE Technical Committee

• Autonomic Computing Systems
  – IBM

• Self-Aware Computer Systems
  – DARPA Workshop 2004

• Integrated Intelligent Capabilities
  – AAAI’06 Special Track
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