How Minds Work
Consciousness

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Philosophical Consciousness

- Phenomenal (subjective) consciousness
- Qualia – the stuff of experience
- The mind-body problem
- (Philosophical) zombie
  - Acts indistinguishably from a human
  - Claims subjective consciousness
- Can zombies exist?
- The hard problem
Scientific Consciousness

• Avoided for a century by behaviorists
• Claimed to be impossible
• Rekindled by Baars, Mandler & others via a twenty-year effort
• Going concern today with journals, organization, conferences, etc.
• Pursued by philosophers, neuroscientists, psychologists, AI researchers
Scientific Study of Consciousness

- Philosophers – clarifying concepts
- Neuroscientists – neural correlates
- Psychologists – functional models
  - Baars, Global Workspace Theory
- AI researchers – computational models
  - Franklin, IDA Model
Functions of Consciousness

- Produce internal virtual reality
  – create a world
- Inform action selection
- Seize opportunities, avoid dangers
- Recruit internal resources
- Learn
Functional vs Phenomenal

• Functional consciousness – performs roles that consciousness plays in agents
• Phenomenal consciousness – subjective experience, qualia
• Only functional claimed for software agents and robots
• What about non-human animals?
Spatially Sensitive Senses

- Sense organ movement produces apparent motion at its surface
- E.g. human vision—press eyeball
- Bacterium nutrient gradient sensing is not spatially sensitive
- Temperature sensing by a thermostat is not spatially sensitive
Merker’s Solution

• Agents with spatially sensitive senses must compensate
• Provides pressure for evolution of phenomenal consciousness
• Earthworms may use other mechanisms or may be phenomenally conscious
• Artificial agents (IDA & robots) not yet phenomenally conscious
Codelets

- Small pieces of code each performing a simple, specialized task
- Often waits as a demon, watching for a chance to act
- Implement processors from Global Workspace theory
Attention Codelets

- Attention—process of bringing to consciousness
- Look at Long-Term Working Memory
- Form coalitions with information codelets
- Information codelets = slipnet nodes = perceptual symbols
Attention Codelets look for

- Conflicts between current and past events (CMattie)
- Particular kinds of information
  - Find me a job (IDA)
  - Work on an F-16 preference (IDA)
- Contiguous motion
- Causation (temporal contiguity)
Particular Information Codelets

- **Intention codelet**
  - Generated at each volitional goal selection
  - Looks for opportunities to approach goal

- **Expectation codelet**
  - Generated with each action selection (behavior net)
  - Looks for outcome of the action
  - More active with unexpected outcome
Stimulus from Internal Environment

Stimulus from External Environment

Sensory Memory

Autobiographical Memory

Perceptual Memory (Slipnet)

Working Memory Preconscious Buffers

Transient Episodic Memory

Long-term Working Memory

Perception Codelets

Consolidation

Cue

Copy Over

Local Associations

Look At

Episodic Learning

Attention Codelets

Coalitions

Senses

Perceptron

Cue

Interpret

Local Associations

Attentional Learning

Episodic Learning

Perceptual Learning

Conscious Broadcast

Predictive Learning

Procedural Memory (Schema)

Action Selection (Behavior Net)

Schema instantiate, bind, activate

Procedural Learning

Expectation and Intention Codelets

Winning Coalition

Competition for Consciousness

Red indicates feelings or emotions are involved
Competition for Consciousness

• Coalitions compete for consciousness
• Relevance, importance, urgency, insistence, etc., measured by affect
• Coalition with highest average activation wins
• Contents of winning coalition broadcast
Conscious Broadcast

- Winning coalition of codelets occupies the Global Workspace (a tautology)
- The contents of Global Workspace are broadcast to every codelet
- The result is learning of several kinds, and the recruitment of resources
Readings

• Read about Philosophical Consciousness in

• Read about Merker’s Solution in
Email and Web Addresses

• Stan Franklin
  – franklin@memphis.edu
  – www.cs.memphis.edu/~franklin

• “Conscious” Software Research Group
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