How Minds Work
Minds, Agents, Senses, Actions

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Two Burning Questions for Me

• How do minds work?
  – Human minds
  – Animal minds
  – Artificial Minds

• How to make smart software agents?
  – Copy them after humans
Question: How do minds work? What would an answer be like?

A framework within which to understand the various mental processes about which one might become curious.

My answer will take most of the semester.
What is a *mind*?

A mind is a control structure for 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
Examples of Autonomous Agents

• We humans
• Most (all?) animals
• Computer viruses
• Some mobile robots
• Autonomous software agents
• Some organizations
Environment?

- Physicalist assumption: There’s a real world out there
- Cyberspace is part of the real world
- Artificial environments also exist
- Causality assumption: Causality operates, i.e., the universe is lawful
Sense the environment?

- Humans: sight, hearing, touch, smell
- Other animals:
  - Bats, dolphins — echolocation
  - Sharks — electroreception
- Photo, mechano, chemo, electro, magneto reception
- Artificial senses, e.g. strings of characters
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
Illusory Motion
Illusory Woman

The apparent woman is produced by

- A potted plant
- A shelf
- A cat
- A wine glass
- A plate
- A clothesline
- A pair of stockings
We each create our own world

• There is no RED out there, only wavelengths of light
• There is no sound when the unattended tree falls in the forest, only vibrations in the air
• The smell of smoke is an inference drawn from molecules in the air
Illusions of the senses tell us the truth about perception

For a website devoted to this proposition, go to

http://www.michaelbach.de/ot/index.html
The **only** question there is!
What do I do next?

For any autonomous agent
Cognition is in the service of action selection
Everything else is a side effect
Its own agenda?

- Motivation must be built in
- Either by evolution or a designer
- Can be causally implemented as in a thermostat
- Implemented by feelings and emotions in humans and other animals
Actions affect sensing?

- Structural coupling to its environment
- Sensors must be appropriate to needs
- Effectors must be appropriate to needs
- Effectors must change the environment
- Sensors must record those changes
Reactive Agents à la Sloman
Add Deliberation

TOWARDS DELIBERATIVE AGENTS

perception

DELIBERATIVE PROCESSES
(Planning, deciding, scheduling, etc.)

Long term memory

Motive activation

Variable threshold attention filter

REACTIVE PROCESSES

THE ENVIRONMENT

action
Add Meta-Management

META-MANAGEMENT (reflective) processes

DELIBERATIVE PROCESSES (Planning, deciding, scheduling, etc.)

REACTIVE PROCESSES

THE ENVIRONMENT

perception

action

Variable threshold attention filter

Long term memory

Motive activation

HMW: Minds, Agents, Senses, Actions
Primitives

• Every autonomous agent must come equipped with
  – Primitive sensors—sensory receptors
  – Primitive effectors—motor output
  – Primitive motivators—of some sort

• These primitives put fundamental limits on what the agent can sense and do
Action Selection Paradigm of Mind

- Best viewed as degree rather than as Boolean
- Aggregate rather than monolithic
- Enabled by disparate mechanisms
- Overriding task to produce the next action
- Operates on sensations to create information
- Reconstructs memories (prior information)
- Is implementable on machines
A Cognitive “Theory of Everything”

- Sensation
- Perception
- Feeling & Emotion
- Working memory
- Episodic memory
- Consciousness
- Learning
- Deliberation
- Volition
- Automization
- Action Selection
- Problem solving
- Self
- Metacognition
Readings in *Artificial Minds*

- Action Selection Paradigm pp. 17-18
- Pandemonium Theory pp. 234-244
- Copycat Architecture pp. 347-362
- Schema Mechanism pp. 314-324
- Sparse Distributed Memory pp. 330-344
- Behavior Networks pp. 244-258

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