Reactive and Hybrid Agents

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Abstract

We summarize [Wooldridge, 2002, Chapter 5].

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- Maybe, intelligent behavior emerges from the interaction of simple behaviors [Minsky, 1988].
- These trends gave rise to behavioral, situated, reactive agent architectures.

The Subsumption Architecture

- Proposed by Brooks in [Brooks, 1986]: for robots.
- Extended it into a new view of AI, [Brooks, 1991a, Brooks, 1991b]. Key ideas:
    - Intelligent behavior does not require explicit representations.
    - Intelligent behavior does not require abstract (symbolic) reasoning.
    - Intelligence is an emergent property of certain complex systems.

Rodney A. Brooks

Subsumption Basic Ideas

- Situatedness and embodiment- an agent sits in a world and has a body.
- Emergent Intelligence- an agent's intelligence arises out of its interactions with the environment and is "in the eye of the beholder."
- All these ideas are embodied in the subsumption architecture.

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- We define the inhibition relation $\prec$, and say $b_1 \prec b_2$ when we mean that b_1 inhibits b_2

Action Selection

```
function action(p:P) : A
var fired
var selected
begin
  fired ← {(c, a) | (c, a) ∈ ℜ ∧ p ∈ c}
  for each (c, a) ∈ fired do
    if ¬(∃(c′, a′) ∈ fired such that (c′, a′) ≺ (c, a)) then
      return a
    end-if
  end-for
  return null
end
```

Mars Example

Steels' Mars Exploration Problem.

The objective is to explore a distant planet, and in particular, to collect sample of a precious rock. The location of the samples is not known in advance, but it is known that they tend to be clustered

- There is a gradient field that emanates from the mother ship.
- Agents carry radioactive crumbs which they can drop or pick up.
- What are the rules?

Solution

1. If detect an obstacle then change direction.
2. If carrying samples and at the base then drop samples.
3. If carrying samples and not at the base then travel up gradient.
4. If detect a sample then pick sample up.
5. If true then move randomly.

- $1 \prec 2 \prec 3 \prec 4 \prec 5$
- OK, that works, but what if the samples are located in clusters?

Another Solution

1. If carrying samples and at the base then drop samples.
2. If carrying samples and not at the base then drop 2 crumbs and travel up gradient.
3. If sense crumbs then pick up 1 crumb and travel down gradient.

- $1 \prec 6 \prec 7 \prec 4 \prec 8 \prec 5$
- See the Ants models in netlogo.

Limitations

- Agents must have enough information in local environment to determine which action to take.
- How to take into account old or non-local information?
- How do reactive agents learn?
- Emergence (between agent and environment) is hard to engineer. We don't have a methodology.
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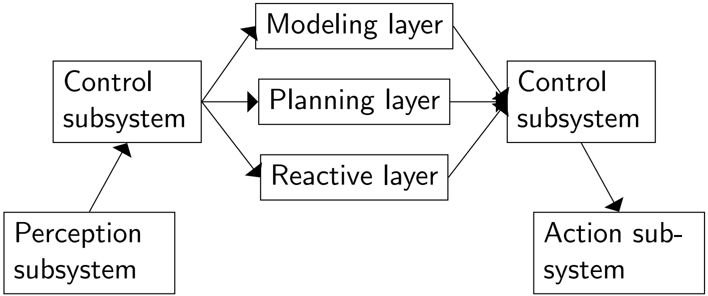
- On the plus side, it has been a very successful method for building robots, such as Roomba.

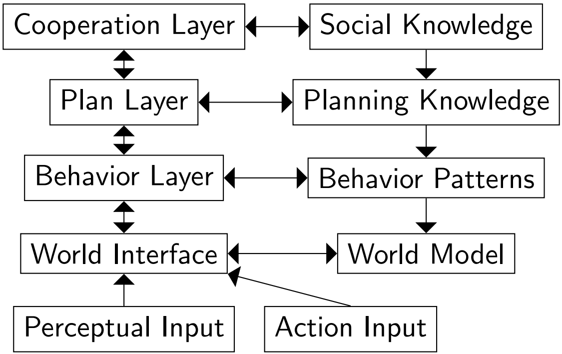
Hybrid Agents

- In horizontal layering all layers are connected to the inputs and output. At the end, a mediator is needed to determine which action to take.
- In vertical layering one-pass the input is connected to one layer, which is connected to the next, and so on until the last layer is connected to the output. Partial results are passed between them. Their functioning resembles that of a corporation.
- In vertical layering two-pass the message bounces off the last layer.

Touring Machines



InterRRaP



- Employs bottom-up activation and top-down execution.

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