

Rethinking the Intelligent Agent Perceive-Reason-Act Loop

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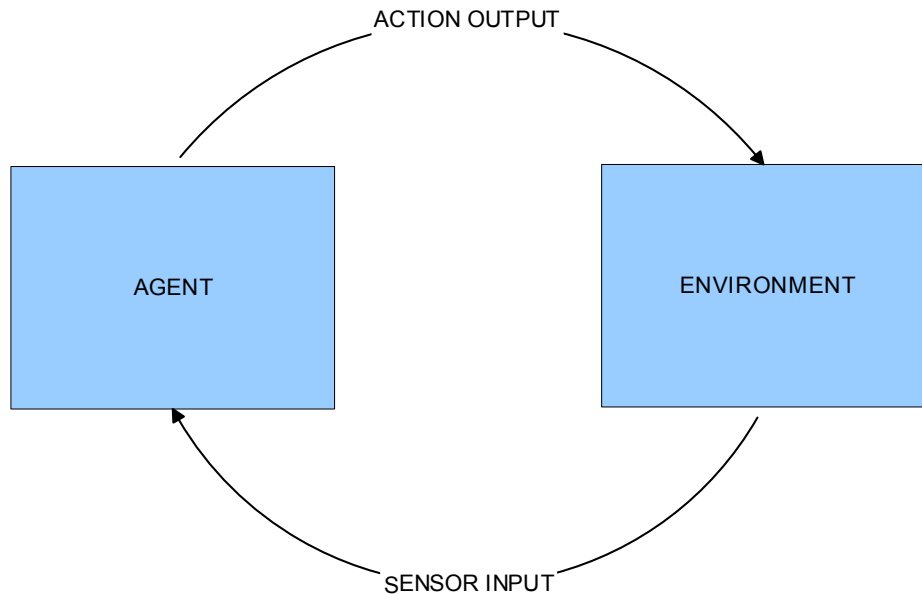
30 October 2002

Agent-Environment Interaction

Key issues with current approaches to agent-environment interaction:

- Treat the agent and the environment as separate entities.
- Communication via inputs and outputs.
- Agent-Environment designs do not follow claims about:
 - Agents being situated.
 - The environment being important.

Agent-Environment Interaction Loop



Agent Control Loop...

Pythonic Version of Wooldridge's Agent Control Loop

```
while True:  
    observe_the_world()  
    update_internal_world_model()  
    deliberate_about_which_intention_to_acheive()  
    use_means_end_reasoning_to_find_a_plan()  
    execute_the_plan()
```

Or the BDI Control Loop...

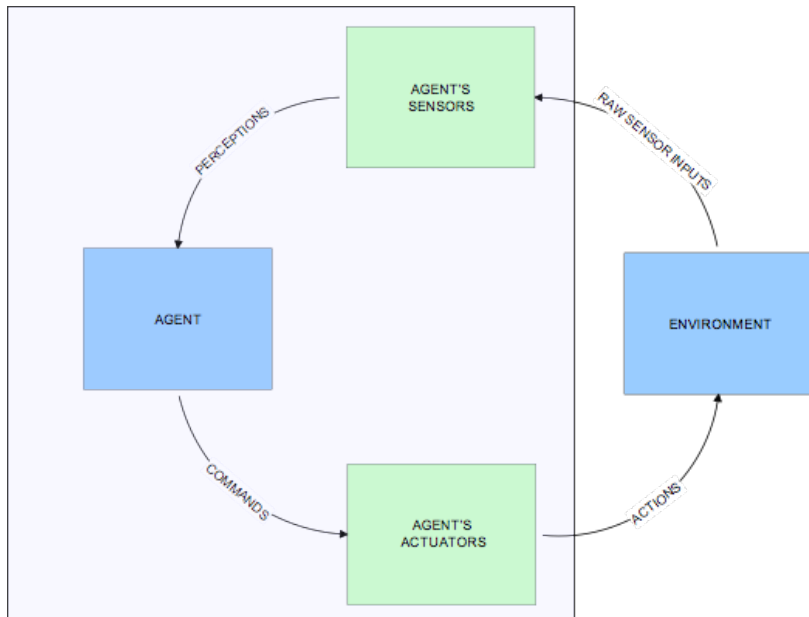
Adapted from Wooldridge...

```
procedure BDI( $B_0, I_0$ )  
   $B \leftarrow B_0$   
   $I \leftarrow I_0$   
  while True do  
     $\rho \leftarrow \text{get\_next\_percept}();$   
     $B \leftarrow \text{brf}(B, \rho);$   
     $D \leftarrow \text{options}(B, I);$   
     $I \leftarrow \text{filter}(B, D, I);$   
     $\pi \leftarrow \text{plan}(B, I);$   
     $\text{execute}(\pi);$   
  end while  
end procedure
```

Let's dig deeper...

- Begin to look at the agent control loop and the interaction with the environment in more detail.
- The interaction between agent and environment needs to be broken down into components, step by step.
- Start looking at how inputs/outputs are generated... i.e. look at sensors and actuators.

A level down...



Labels in the Environment

- One of the things that is sent to an agent's sensors is the possibility of pre-labeled entities in the environment.

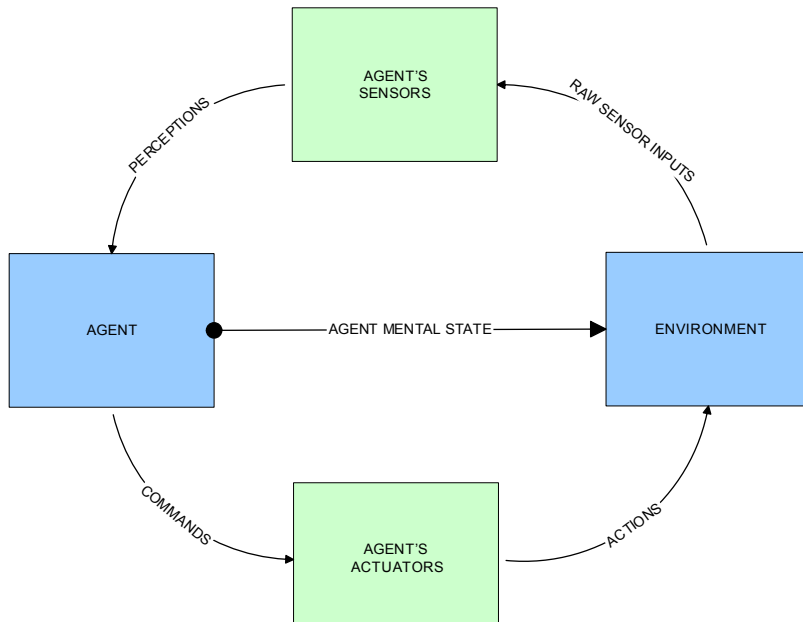
We can begin to formulate a theory...

- In a multi-agent system we have n agents, $A_1 \dots A_n$.
- Each agent has m sensors.
- We can specify the i -th agent's j -th sensor as S_{ij}

Agent Mental States

- Each agent A_i can be in a single mental state m_i .
- The mental state may be the agent's beliefs and intentions.
- $m_i = \{B_i, I_i\}$
- Consider the sensing of the environment to be a function of the agent's current mental state.

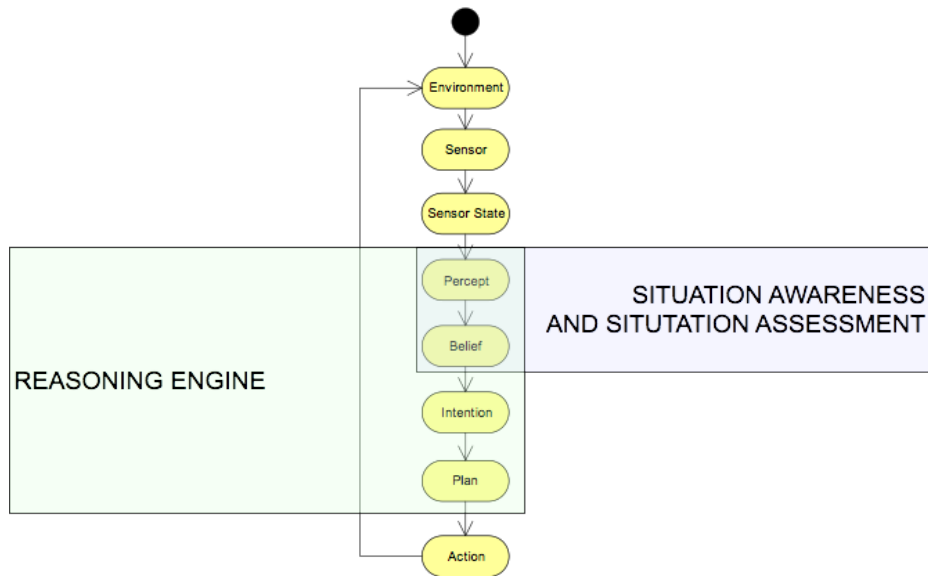
Agent Mental State in the Loop...



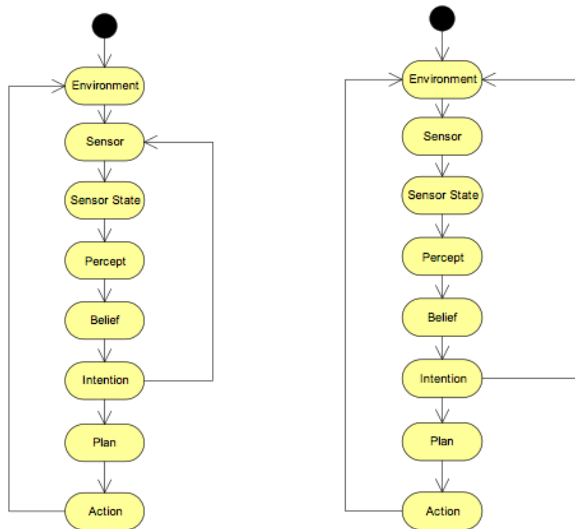
Perception and Mental State

- Implies perception/sensing are a function of an agent's mental state.
- What you perceive as an agent depends on what you are doing and what you believe you are doing (beliefs, intentions).
- This fits in with J.J. Gibsons ideas of direct perception for ecological psychology.
- $\text{Sensor}(\sigma_i, \mathbf{e}, m_i) := \sigma_{i+1}$

The Agent-Environment Loop Revisited



Intention Based Feedback Loop



Environmental Representation

- Still need to look at environmental representation options
 - Flat
 - Hierarchical/Relational
 - Labels (Dynamic or Pre-Processed)
 - Intention Oriented Affordances
- Dynamic agent (tailored to the agent)
- Static environment

So what is the goal then?

- To create a *truly* situated agent.
- Affordances: opportunity for action
- Together with a tighter agent-environment feedback loop; might just do the trick.

Affordances

- Affordances are a function:
 - The subset of the environment that the agent is/can perceive using its sensors.
 - The agent's mental state.
 - The agent's current activity...
- Do we need to distinguish between Intention/Activity/Action?

Example: Jumping a Creek

- My intention is to get to Town B from Town A
- I have a plan to *run* from A to B
- I have a plan to *walk* from A to B
- I see a creek
- If I am running the creek *affords* jumping
- Here the affordance is a function of the activity rather than intention.

How do we build such an agent?

- Agent *announces* to the environment what it can see.
- Agent *announces* to the environment what it is doing (activity or action) or maybe even intention.
- Environment/Affordance engine somehow binds what a I can see with what I am doing, generating affordances for the things in the environment.

Issues (1)

- How does the agent sense/perceive the affordances?
- Is there an affordance *sensor*?
- Does the agent get affordance percepts (direct percepts) in addition to regular percepts?
- How does the agent then use these affordances in the next deliberation step?

Issues (2)

- What do affordances look like?
Names, labels, relations?
- `can-jump(creek)` → What are these?
- How does having these affordances affect your intention generation process?
- Need more examples...

Example

