Rational OpenCog Controlled Agent

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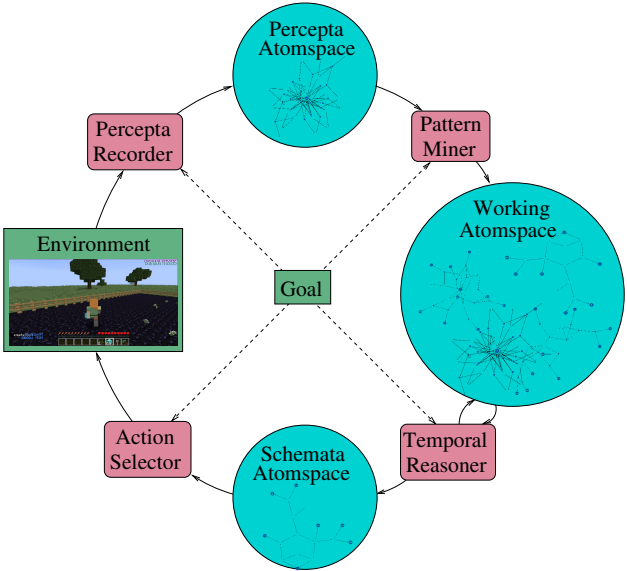
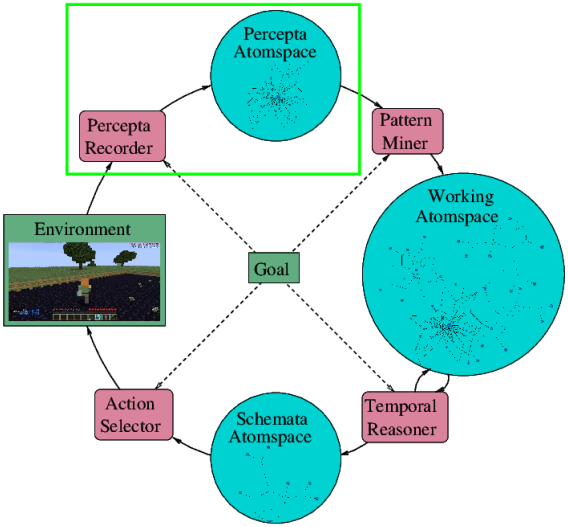
Artificial General Intelligence 2023 (AGI-23)

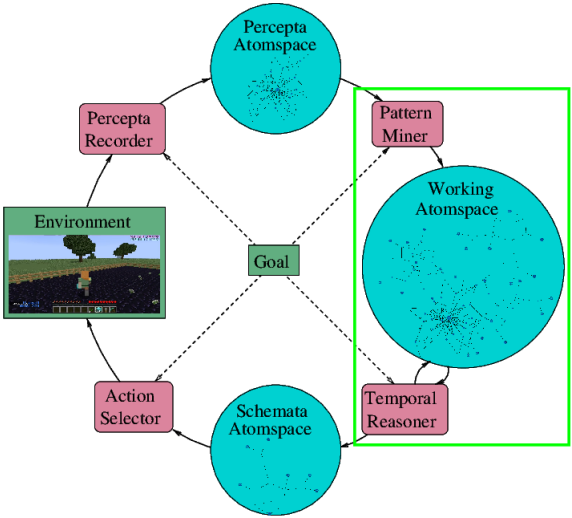

Percepta Atomspace
Pattern Miner
Working Atomspace
Temporal Reasoner
Schemata Atomspace
Action Selector
Environment
Goal
Percepta Recorder



Timestamped Recorded Events

Time	*Event*	*Evaluation*
⋮	⋮	⋮
10	*reward(0)*	*reward(0)(10) = True*
10	*outside(house)*	*outside(house)(10) = True*
10	*hold(key)*	*hold(key)(10) = True*
10	*go(house)*	*go(house)(10) = True*
11	*inside(house)*	*inside(house)(11) = True*
11	*collect(diamond)*	*collect(diamond)(11) = True*
11	*reward(0)*	*reward(0)(11) = True*
12	*reward(1)*	*reward(1)(12) = True*
⋮	⋮	⋮

Learning Schemata



Pattern Mining
+
Temporal Reasoning
=
Cognitive Schematics

Pattern Mining Schemata

Time	*Event*
⋮	⋮
10	*reward(0)*
10	*outside(house)*
10	*hold(key)*
10	*go(house)*
11	*inside(house)*
11	*collect(diamond)*
11	*reward(0)*
12	*reward(1)*
⋮	⋮

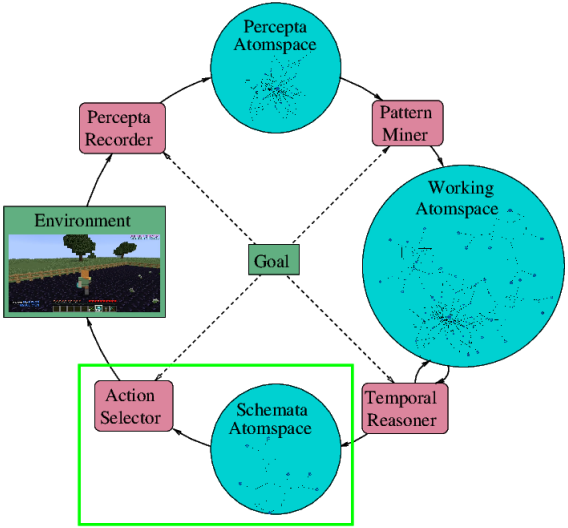
$$\begin{array}{c} \vdots \\ \vdots \\ \vdots \\ hold(key) \wedge go(house) \rightsquigarrow^{1} inside(house) \stackrel{m}{=} <0.83, 0.007> \\ \vdots \\ \vdots \\ \vdots \end{array}$$

Reasoning Schemata

$$\dfrac{\dfrac{\dfrac{\textit{outside(house)} \wedge \textit{get(key)} \rightsquigarrow^{1} \textit{outside(house)} \qquad \textit{outside(house)} \wedge \textit{get(key)} \rightsquigarrow^{1} \textit{hold(key)}}{\textit{outside(house)} \wedge \textit{get(key)} \rightsquigarrow^{1} \textit{outside(house)} \wedge \textit{hold(key)}}\,(\text{CC}) \qquad \textit{outside(house)} \wedge \textit{hold(key)} \wedge \textit{go(house)} \rightsquigarrow^{1} \textit{inside(house)}}{\textit{outside(house)} \wedge \textit{get(key)} \wedge^{1} \textit{go(house)} \rightsquigarrow^{2} \textit{inside(house)}}\,(\text{PD})$$

$$\vdots$$

$$\textit{outside(house)} \wedge \textit{get(key)} \wedge^{1} \textit{go(house)} \wedge^{1} \textit{collect(diamond)} \rightsquigarrow^{3} \textit{reward(1)} \stackrel{\text{m}}{=} <0.83, 0.005>$$



Cognitive Schematics

$$\vdots$$

$$\text{Context} \wedge \text{Action} \rightsquigarrow^{T} \text{Goal}$$

$$\vdots$$

$$\Downarrow$$

Action

The Paradox of Choice

Many applicable schemata

$$
\begin{aligned}
C_1 \wedge A_1 &\rightsquigarrow^{T_1} G &&\stackrel{\text{m}}{=} && TV_1 \\
&\vdots \\
C_{9999} \wedge A_{9999} &\rightsquigarrow^{T_{9999}} G &&\stackrel{\text{m}}{=} && TV_{9999}
\end{aligned}
$$

The Paradox of Choice

Many applicable schemata

$$
\begin{aligned}
C_1 \wedge A_1 &\rightsquigarrow^{T_1} G &&\stackrel{\text{m}}{=} && TV_1 \\
&\vdots \\
C_{9999} \wedge A_{9999} &\rightsquigarrow^{T_{9999}} G &&\stackrel{\text{m}}{=} && TV_{9999}
\end{aligned}
$$

With different risk/reward profiles

$$
\begin{aligned}
C_1 \wedge A_1 &\rightsquigarrow^{T_1} G &&\stackrel{\text{m}}{=} && <0.9\ 0.1> \\
C_2 \wedge A_2 &\rightsquigarrow^{T_2} G &&\stackrel{\text{m}}{=} && <0.6\ 0.9>
\end{aligned}
$$

The Paradox of Choice

Many applicable schemata

$$\begin{aligned} C_1 \wedge A_1 &\rightsquigarrow^{T_1} G &&\stackrel{\text{m}}{=} && TV_1 \\ &\vdots \\ C_{9999} \wedge A_{9999} &\rightsquigarrow^{T_{9999}} G &&\stackrel{\text{m}}{=} && TV_{9999} \end{aligned}$$

With different risk/reward profiles

$$\begin{aligned} C_1 \wedge A_1 &\rightsquigarrow^{T_1} G &&\stackrel{\text{m}}{=} && <0.9\ 0.1> \\ C_2 \wedge A_2 &\rightsquigarrow^{T_2} G &&\stackrel{\text{m}}{=} && <0.6\ 0.9> \end{aligned}$$

Some contradicting each other

$$\begin{aligned} C_1 \wedge A &\rightsquigarrow^{T_1} G &&\stackrel{\text{m}}{=} && <0.9\ 0.5> \\ C_2 \wedge A &\rightsquigarrow^{T_1} G &&\stackrel{\text{m}}{=} && <0.1\ 0.5> \end{aligned}$$

Balancing exploitation and exploration

Solomonoff-ish Induction ↘
+
Thompson Sampling ↙

Second Order Mixture

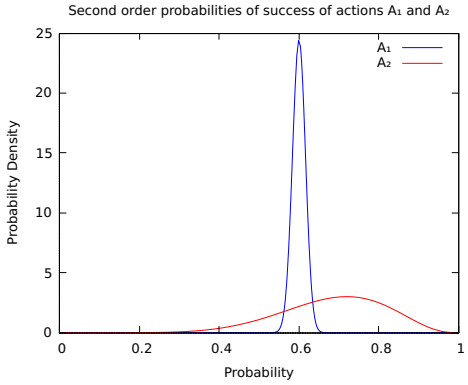
Balancing exploitation and exploration

Solomonoff-ish Induction ↘

\+

Thompson Sampling ↙

Second Order Mixture



Example: Collect Diamonds

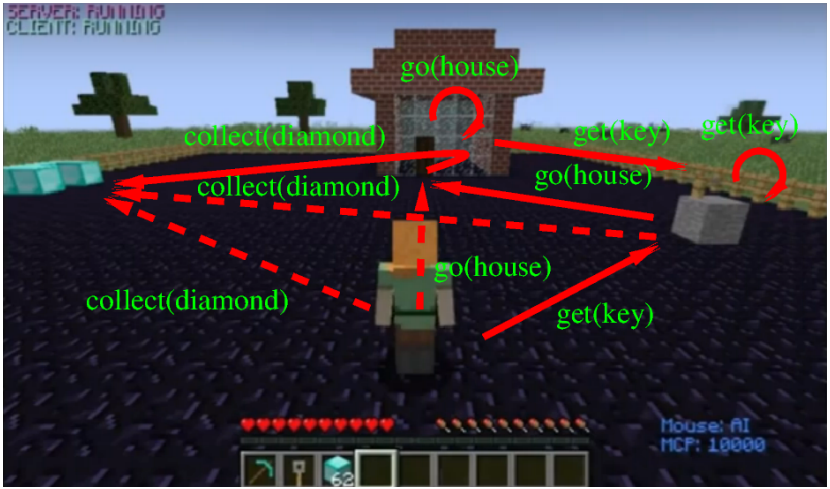
Actions

- get(key)
- go(house)
- collect(diamond)

Percepts

- outside(house)
- inside(house)
- hold(key)
- next(door)
- reward(1)
- reward(0)

Example: Collect Diamonds



1. Exploration
2. Learning
3. Exploitation

Example: Collect Diamonds

Example: Collect Diamonds

$\text{outside(house)} \wedge \text{get(key)} \nearrow^1 \text{go(house)} \nearrow^1 \text{collect(diamond)} \rightsquigarrow^3 \text{reward(1)}$

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$\text{hold(key)} \wedge \text{go(house)} \nearrow^1 \text{collect(diamond)} \rightsquigarrow^2 \text{reward(1)}$

Example: Collect Diamonds

$\text{outside(house)} \wedge \text{get(key)} \nearrow^1 \text{go(house)} \nearrow^1 \text{collect(diamond)} \rightsquigarrow^3 \text{reward(1)}$

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$\text{hold(key)} \wedge \text{go(house)} \nearrow^1 \text{collect(diamond)} \rightsquigarrow^2 \text{reward(1)}$

$\text{inside(house)} \wedge \text{collect(diamond)} \rightsquigarrow^1 \text{reward(1)}$

Example: Collect Diamonds

$\text{outside(house)} \wedge \text{get(key)} \nearrow^1 \text{go(house)} \nearrow^1 \text{collect(diamond)} \rightsquigarrow^3 \text{reward(1)}$

$\text{hold(key)} \wedge \text{go(house)} \nearrow^1 \text{collect(diamond)} \rightsquigarrow^2 \text{reward(1)}$

$\text{inside(house)} \wedge \text{collect(diamond)} \rightsquigarrow^1 \text{reward(1)}$

Future Work

- More challenging environments
- Attention Allocation
- Concept creation and schematization
- Plan in the inner world