

# Rational OpenCog Controlled Agent

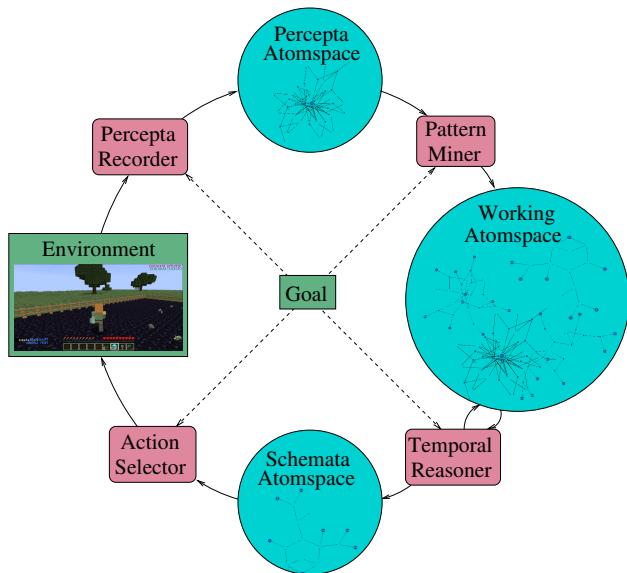
Nil Geisweiller, Hedra Yusuf

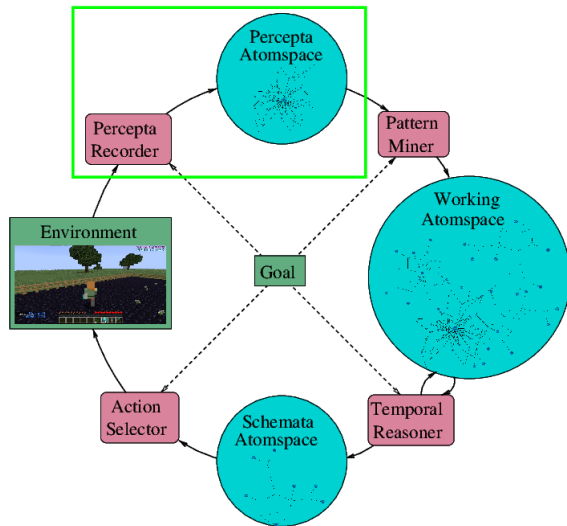
Artificial General Intelligence 2023 (AGI-23)



SingularityNET



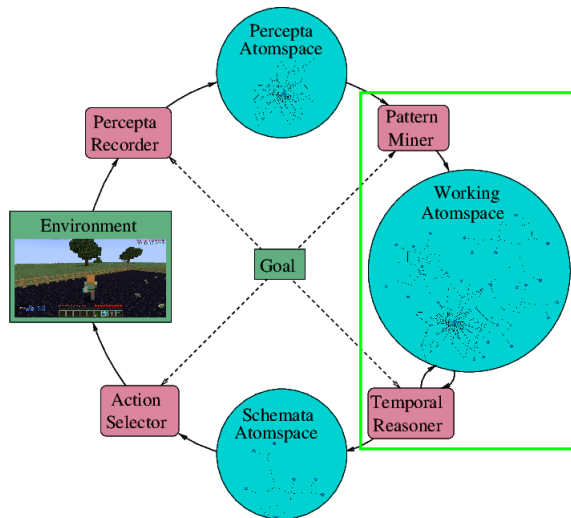




## Timestamped Recorded Events

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

# Learning Schemata



Pattern Mining  
+  
Temporal Reasoning  
=  
Cognitive Schematics

# Pattern Mining Schemata

<i>Time</i>	<i>Event</i>
⋮	⋮
10	<i>reward(0)</i>
10	<i>outside(house)</i>
10	<i>hold(key)</i>
10	<i>go(house)</i>
11	<i>inside(house)</i>
11	<i>collect(diamond)</i>
11	<i>reward(0)</i>
12	<i>reward(1)</i>
⋮	⋮

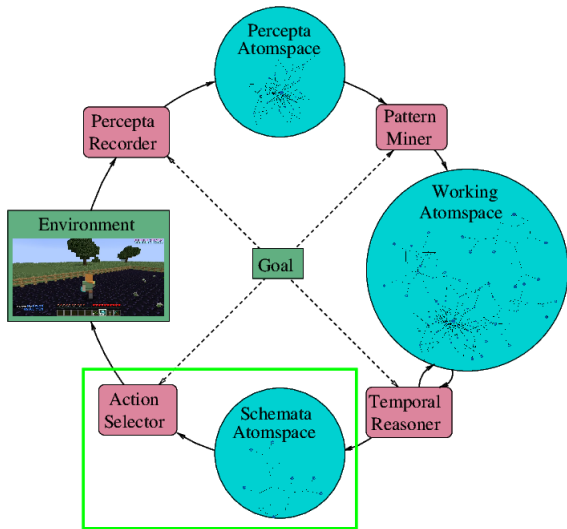
$hold(key) \wedge go(house) \rightsquigarrow^1 inside(house) \stackrel{m}{=} \langle 0.83, 0.007 \rangle$

# Reasoning Schemata

$$\begin{array}{c}
 \frac{\text{outside(house)} \wedge \text{get(key)} \rightsquigarrow^1 \text{outside(house)} \quad \text{outside(house)} \wedge \text{get(key)} \rightsquigarrow^1 \text{hold(key)}}{\text{outside(house)} \wedge \text{get(key)} \rightsquigarrow^1 \text{outside(house)} \wedge \text{hold(key)}} \text{ (CC)} \\
 \frac{\text{outside(house)} \wedge \text{get(key)} \rightsquigarrow^1 \text{outside(house)} \wedge \text{hold(key)} \quad \text{outside(house)} \wedge \text{hold(key)} \wedge \text{go(house)} \rightsquigarrow^1 \text{inside(house)}}{\text{outside(house)} \wedge \text{get(key)} \wedge^1 \text{go(house)} \rightsquigarrow^2 \text{inside(house)}} \text{ (PD)}
 \end{array}$$

⋮

$$\text{outside(house)} \wedge \text{get(key)} \wedge^1 \text{go(house)} \wedge^1 \text{collect(diamond)} \rightsquigarrow^3 \text{reward(1)} \models \langle 0.83, 0.005 \rangle$$



## Cognitive Schematics

$$\begin{matrix} \vdots \\ \text{Context} \wedge \text{Action} \rightsquigarrow^T \text{Goal} \\ \vdots \end{matrix}$$



Action

# The Paradox of Choice

## Many applicable schemata

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



# The Paradox of Choice

## Many applicable schemata

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

## With different risk/reward profiles

$$\begin{array}{ccc}
 C_1 \wedge A_1 \rightsquigarrow^{T_1} G & \stackrel{m}{=} & \langle 0.9 \ 0.1 \rangle \\
 C_2 \wedge A_2 \rightsquigarrow^{T_2} G & \stackrel{m}{=} & \langle 0.6 \ 0.9 \rangle
 \end{array}$$

# The Paradox of Choice

## Many applicable schemata

$$\begin{array}{ccc}
 C_1 \wedge A_1 \rightsquigarrow^{T_1} G & \stackrel{m}{=} & TV_1 \\
 \vdots & & \\
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## With different risk/reward profiles

$$\begin{array}{ccc}
 C_1 \wedge A_1 \rightsquigarrow^{T_1} G & \stackrel{m}{=} & \langle 0.9 \ 0.1 \rangle \\
 C_2 \wedge A_2 \rightsquigarrow^{T_2} G & \stackrel{m}{=} & \langle 0.6 \ 0.9 \rangle
 \end{array}$$

## Some contradicting each other

$$\begin{array}{ccc}
 C_1 \wedge A \rightsquigarrow^{T_1} G & \stackrel{m}{=} & \langle 0.9 \ 0.5 \rangle \\
 C_2 \wedge A \rightsquigarrow^{T_1} G & \stackrel{m}{=} & \langle 0.1 \ 0.5 \rangle
 \end{array}$$

# Balancing exploitation and exploration

Solomonoff-ish Induction ↘

+

Thompson Sampling ↙

Second Order Mixture

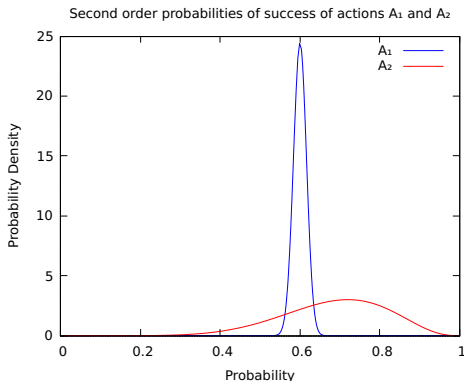
# Balancing exploitation and exploration

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

TODO: exploration

# Example: Collect Diamonds



# Example: Collect Diamonds

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





# Example: Collect Diamonds

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



# Example: Collect Diamonds

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

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



# Example: Collect Diamonds

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

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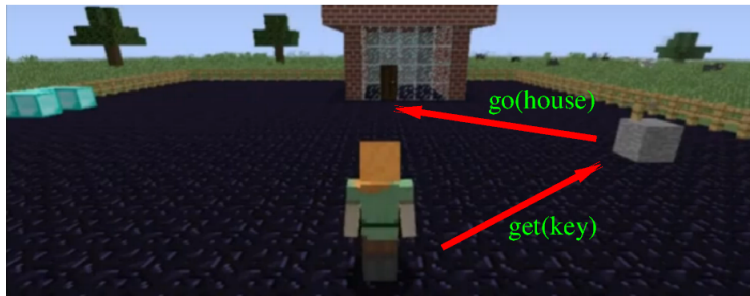


# Example: Collect Diamonds

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

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

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



# Example: Collect Diamonds

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

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

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



# Future Work

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