Agent Newspeak

Common Concepts in Agent Groups, Symmetries and Conformity in a Simple Environment

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27.02.2008

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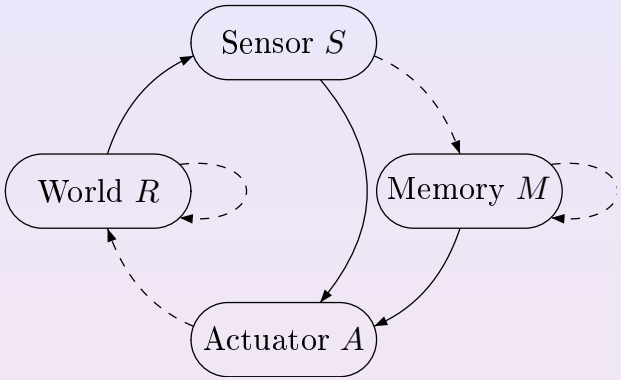
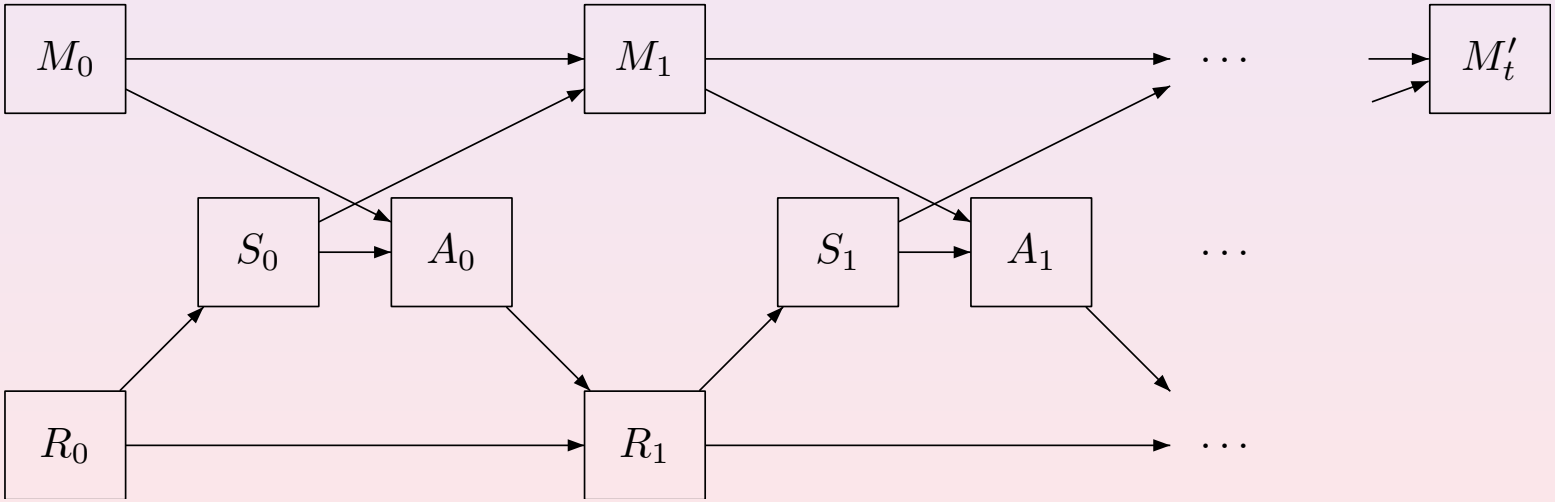
   - Results

Overview

1. Scenario
   - Perception Action Loop
   - Initial Position Capturing
2. Common Concept
3. Symmetry

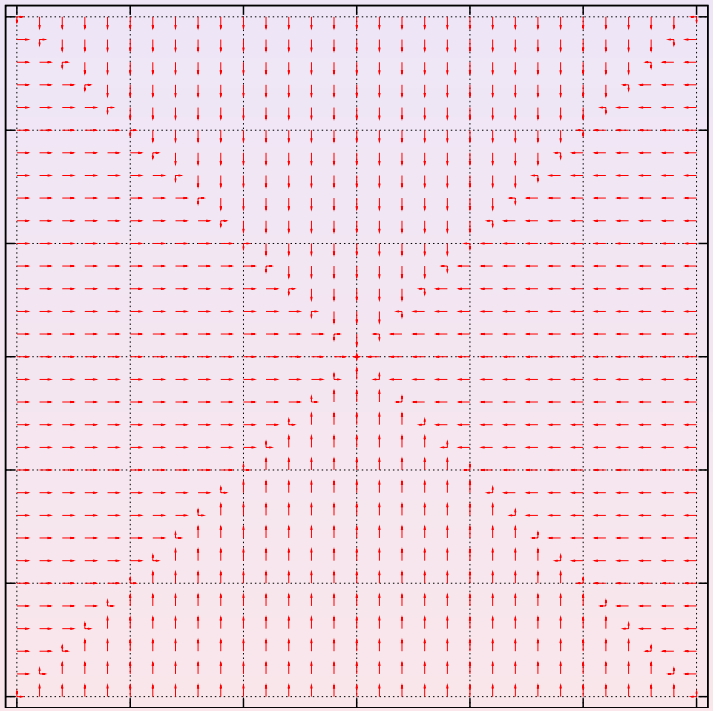
Perception-Action Loop





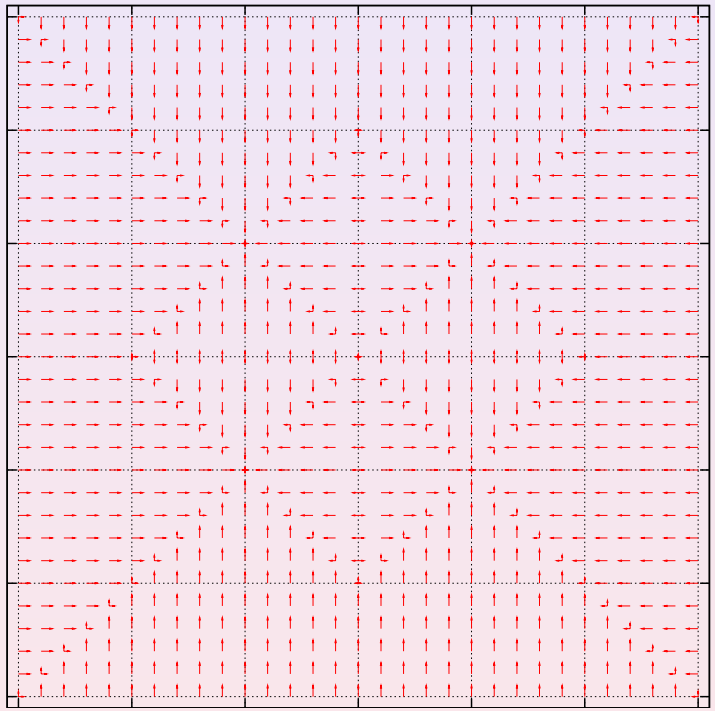
... similar to colloquium talk of Daniel Polani.

Scenarios - Sensor-Values $s \in \mathcal{S}$ for Every Place $r \in \mathcal{R}$ in the World



"s+" = single source in center

from Alexander Klyubin

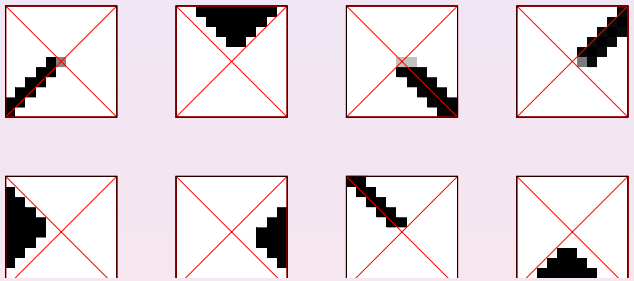


"sq" = 4 sources

new

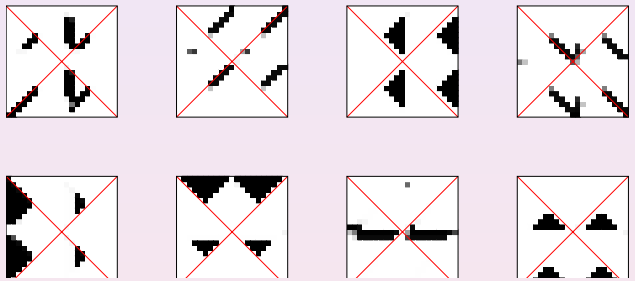
Initial Position Capturing

- Search for a controller (agent) which maximizes $I(R_0; M_{15}) \rightarrow$ Initial position capturing agent.
- Shown is the probability $p(r_0|m_{15})$ for a starting place r_0 given a memory value m_{15} (black = high probability)



single source in center - s+

$I(R_0; M_{15}) = 2.906$ bit



4 sources - sq

$I(R_0; M_{15}) = 2.888$ bit

- Let us call a pair (R_0, M_{15}) a *concept* iff $I(R_0; M_{15}) > 0$.
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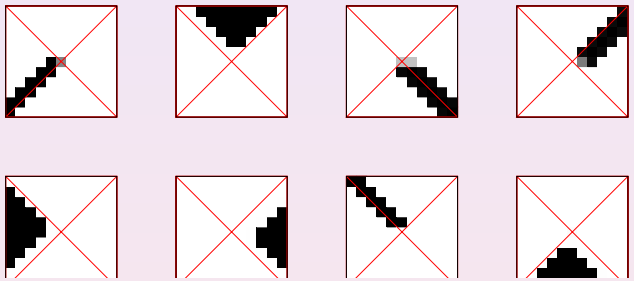

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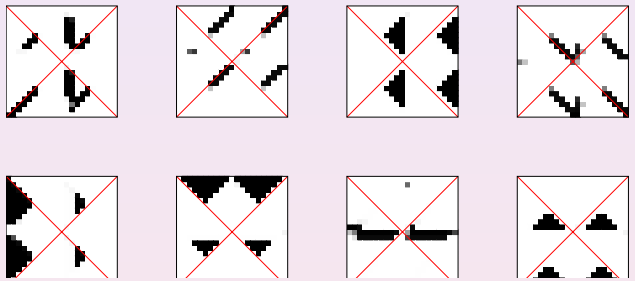

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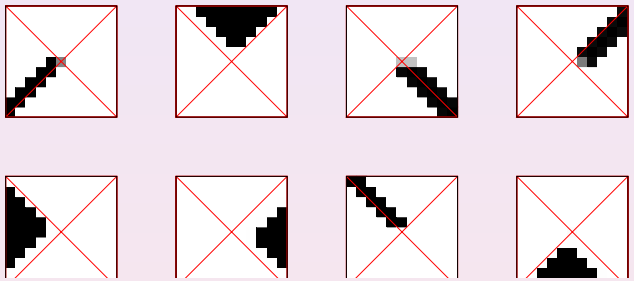

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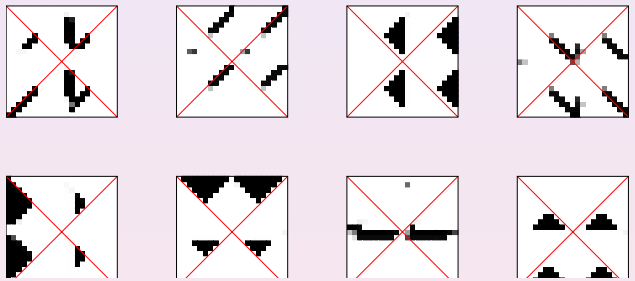

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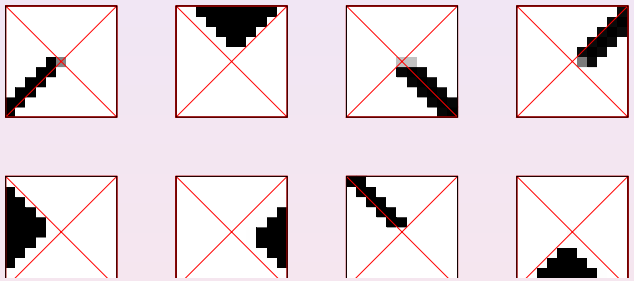

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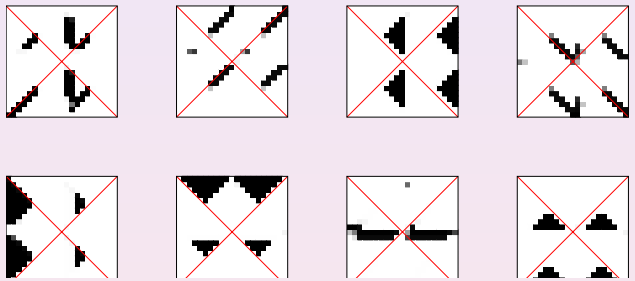

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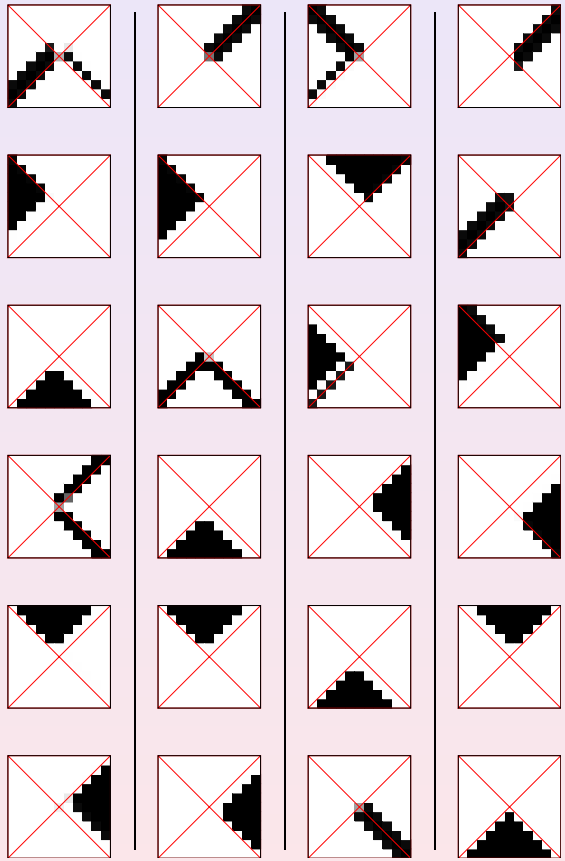
3 Symmetry

Why Common Concepts?

- 4 different good concepts for the initial position capturing agents are shown →
- Intuitively they all looking very similar
- Information theory do not consider permutations
- Difference:
  - Different diagonals where found
  - Even if is was same diagonal, they are not perfectly matching (≈ translation)
- How to combine all symbols of all concepts? ⇒ Common Concepts



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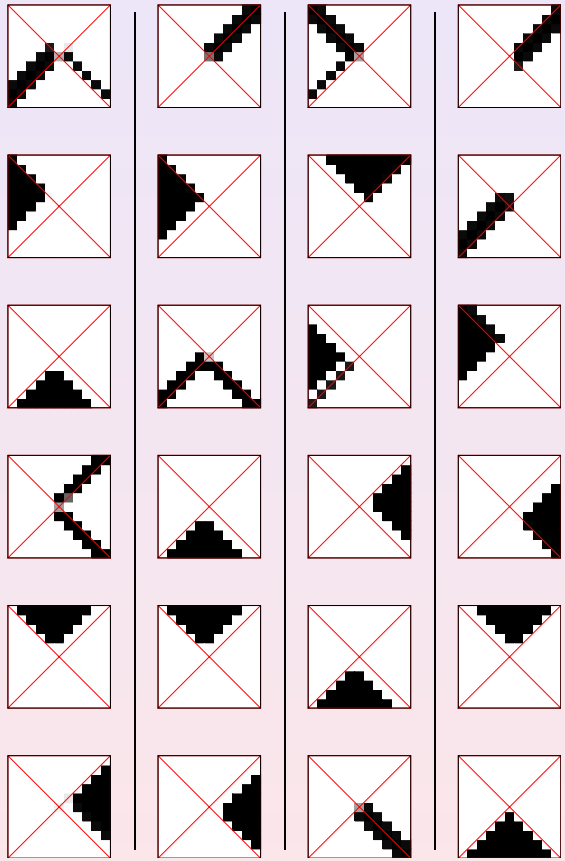

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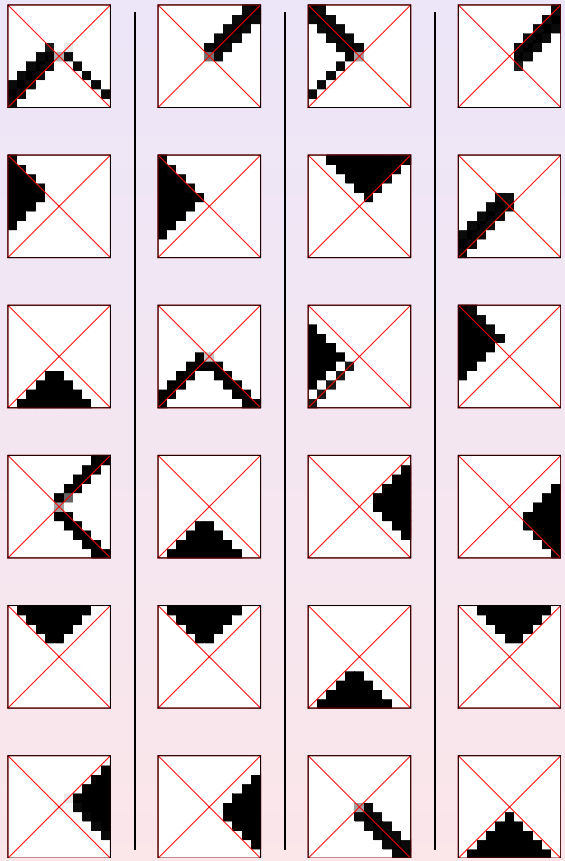

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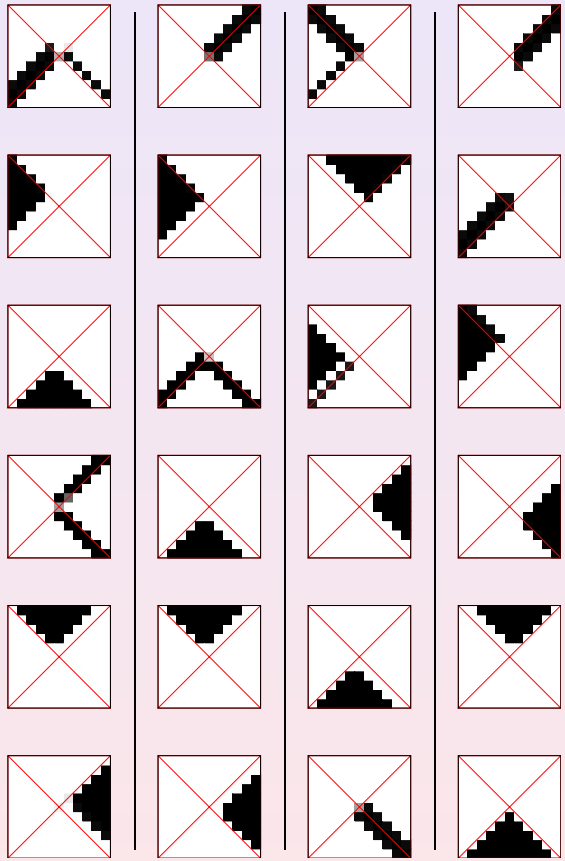

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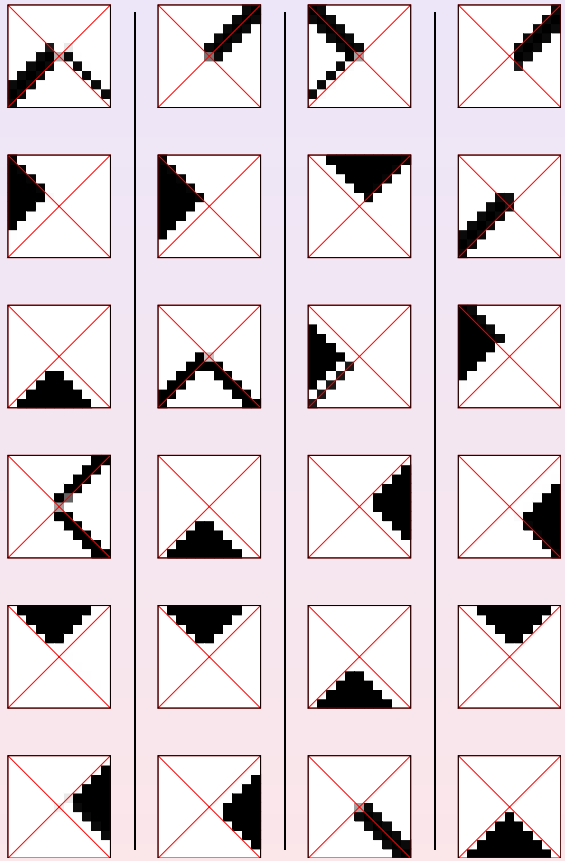

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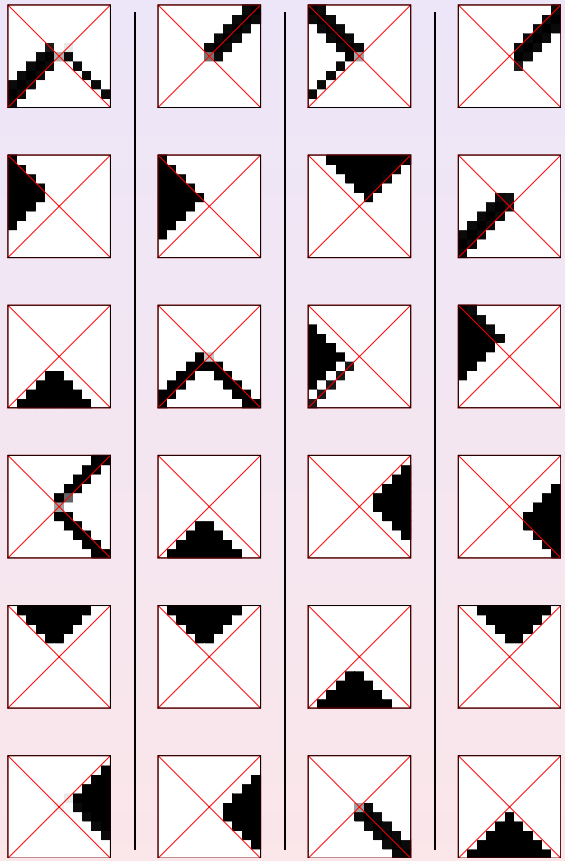

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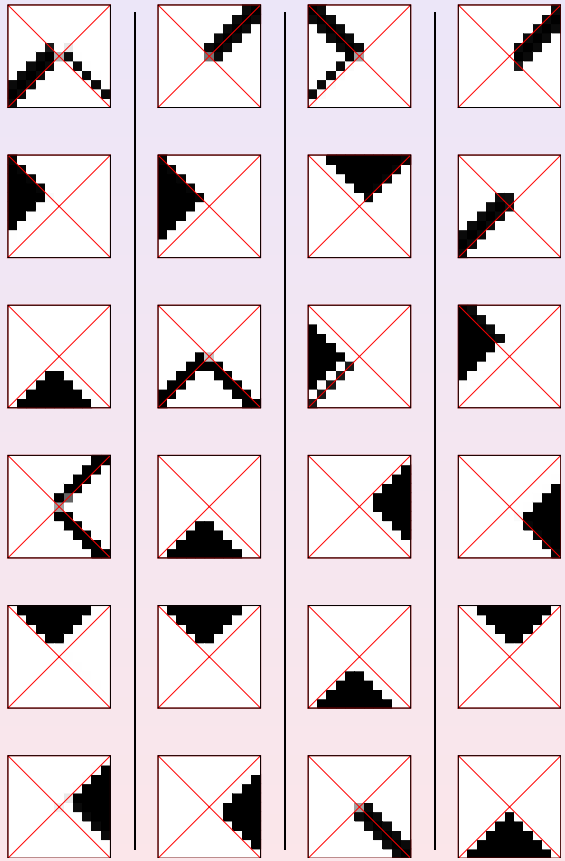

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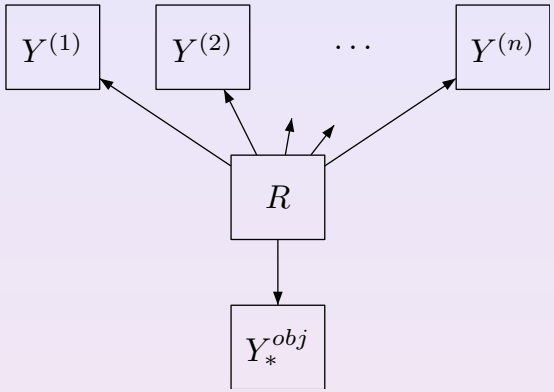

- A deterministic mapping $R \longrightarrow Y_*^{obj}$ which maximized the utility

$$\max \stackrel{!}{=} \sum_i \left[I\left(Y_*^{obj}; Y^{(i)}\right) - \alpha \cdot I\left(R; Y_*^{obj}\right) \right]$$

$$\equiv \left[\sum_i I\left(Y_*^{obj}; Y^{(i)}\right) \right] - \alpha \cdot n \cdot I\left(R; Y_*^{obj}\right)$$

  defines the *objective common concept* $\left(R, Y_*^{obj}\right)$.

- Objective $\longrightarrow$ If you know R, everything about Y_*^{obj} is clear.

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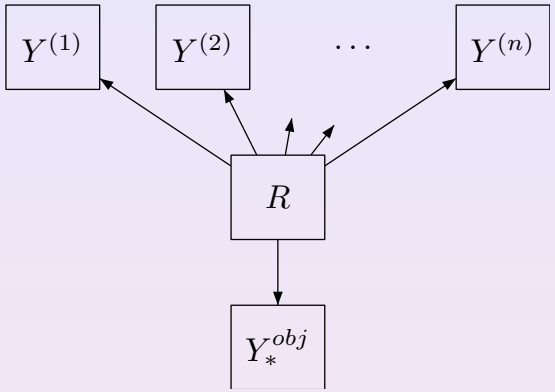

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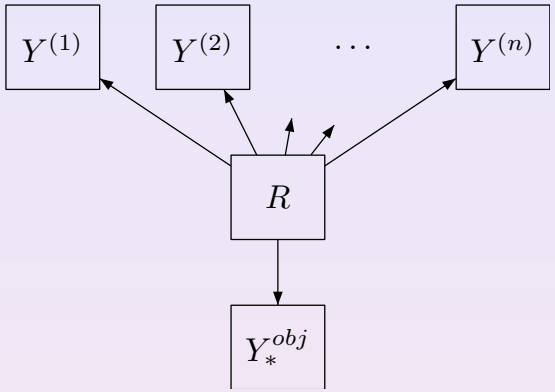

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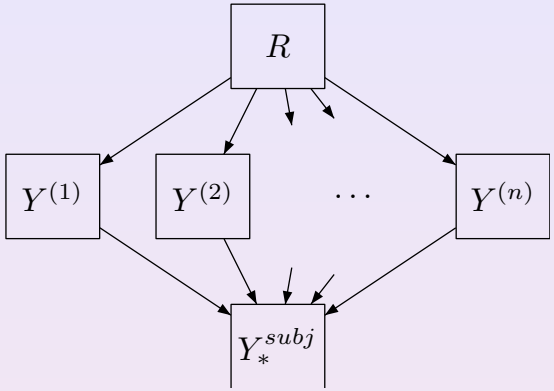

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$$\min \quad \stackrel{!}{=} \quad I\left(Y^{(1)}; \ldots; Y^{(n)} | Y_*^{subj}\right) \equiv \left[\sum_{i=1}^{n} H\left(Y^{(i)} | Y_*^{subj}\right)\right] - H\left(Y^{(1)}, \ldots, Y^{(n)} | Y_*^{subj}\right)$$

  defines the *subjective common concept* $\left(R, Y_*^{subj}\right)$.
- Subjective $\longrightarrow$ the "naming" of a place in $r \in \mathcal{R}$ could be very non-deterministic and depends on the "opinion about the world" of every agent.
- *Superstition* of a concept is $H(Y|R)$ and is a measurement for this "subjectivity".

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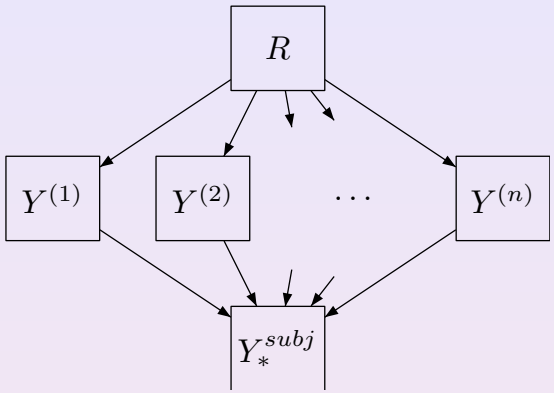

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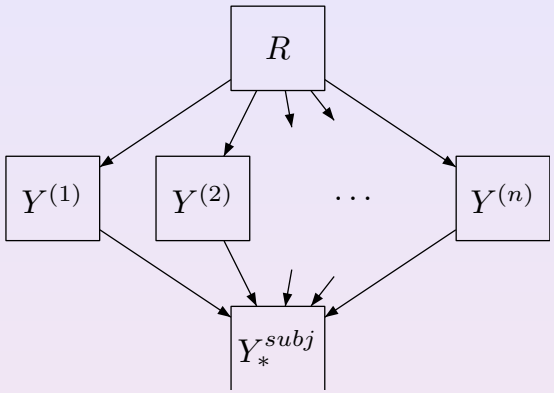

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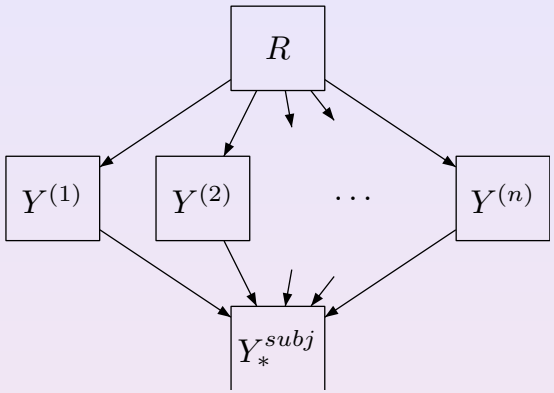

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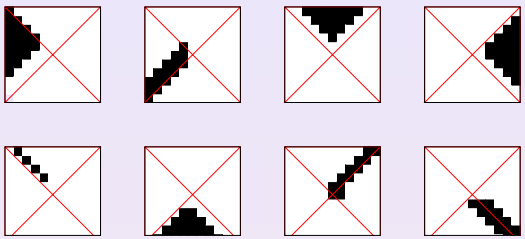
Common Concept Example



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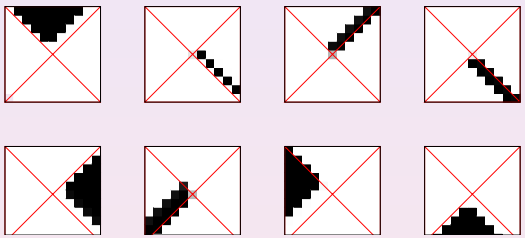

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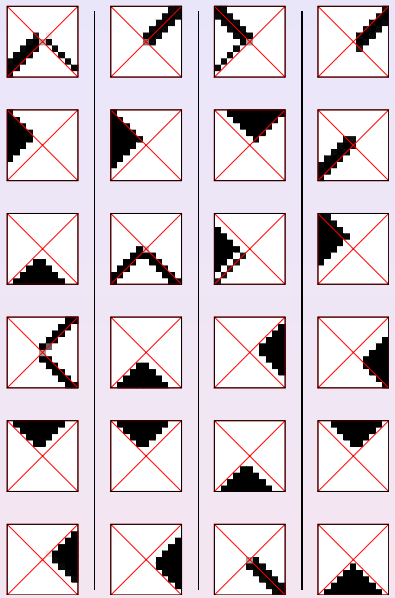

4 Input Concepts

- Almost similar: Crutchfield-distance $D(M_*^{obj}, M_*^{subj}) = H(M_*^{obj}|M_*^{subj}) + H(M_*^{subj}|M_*^{obj}) = 0.38$ bit is very small.
- Less superstition: $H\left(M_*^{subj}|R_0\right) = 0.03$ bit.
- Subjective common concept needs exponentially resources (memory, computation-time, search-space size) in number of input concepts and there size.

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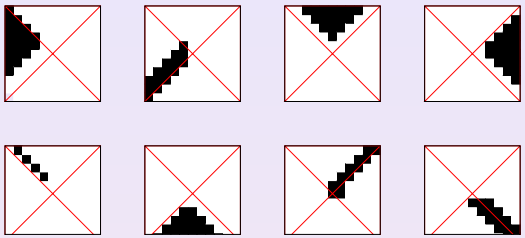

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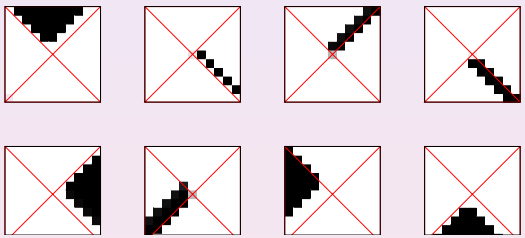

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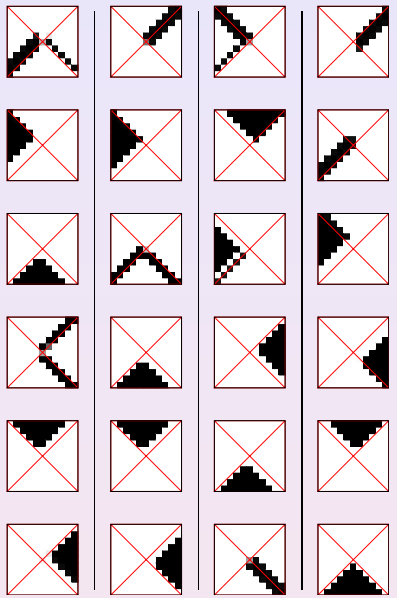

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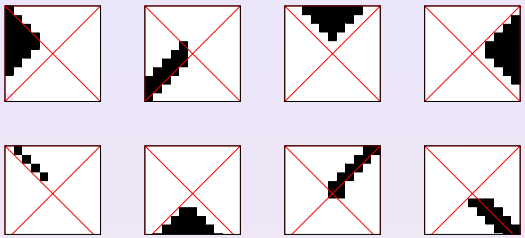
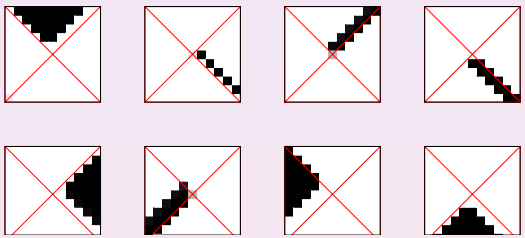


Objective common concept



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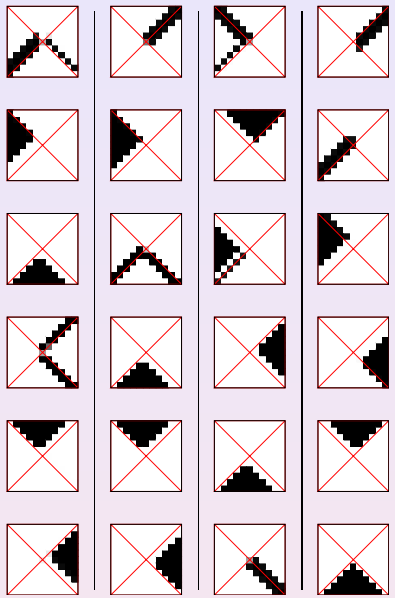

4 Input Concepts

- Almost similar: Crutchfield-distance
  $D(M_*^{obj}, M_*^{subj}) = H(M_*^{obj}|M_*^{subj}) + H(M_*^{subj}|M_*^{obj}) = 0.38$ bit is very small.
- Less superstition: $H\left(M_*^{subj}|R_0\right) = 0.03$ bit.
- Subjective common concept needs exponentially resources (memory, computation-time, search-space size) in number of input concepts and there size.

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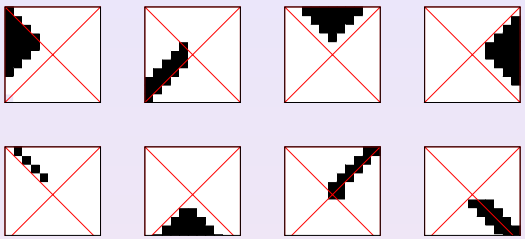

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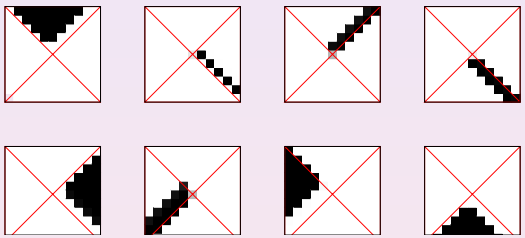

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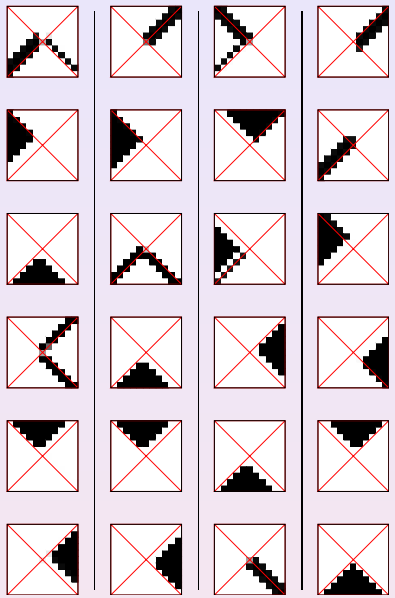

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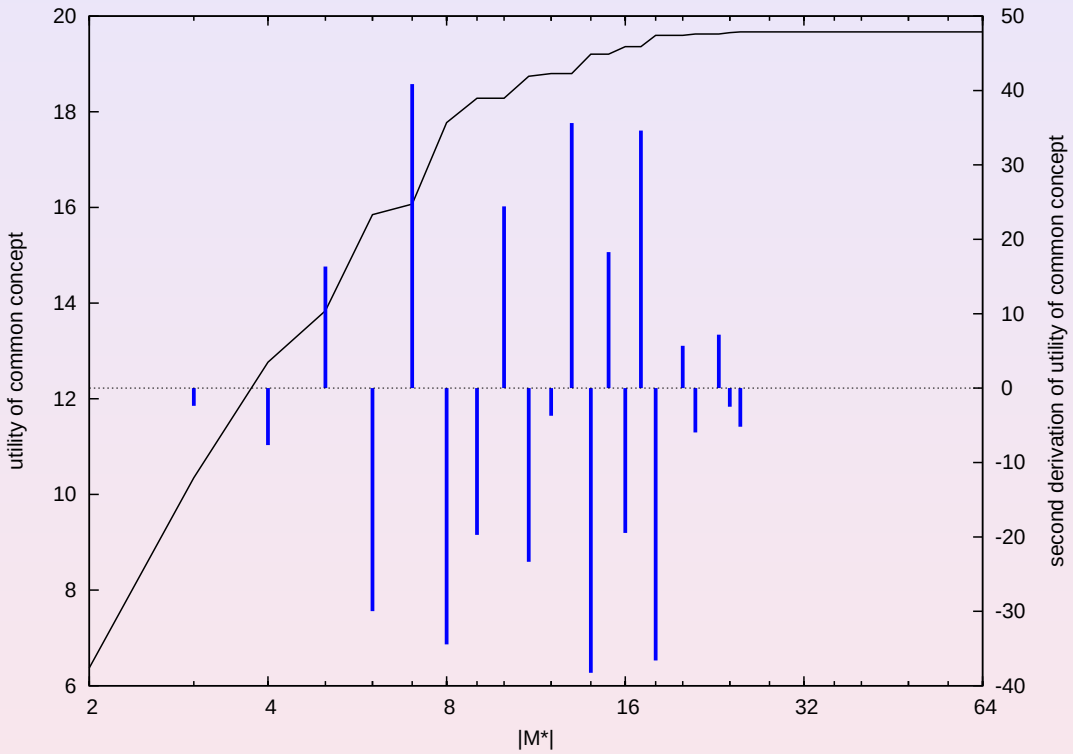
Optimal Concept Size



Utility of objective common concept (10 input concepts with scenario s+ and memory size $|\mathcal{M}| = 8$) depending on concept size $|\mathcal{M}_*|$ and its second derivative. Memory sizes where this derivative becomes negative are good choices.

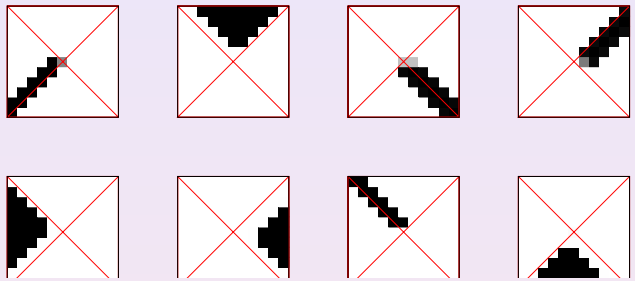
Overview

1 Scenario

2 Common Concept

3 Symmetry
- Idea
- Extrinsic Symmetry
- Intrinsic Symmetry
- Results

Idea for Symmetry



1. Define a set of operations on a concept → *symmetry operation*.
2. Define a utility function for every such symmetry operation. E.g.:
   1. Define a other concept where all "operated concepts" are compared to.
   2. Define how this comparison will be measured.

- We have analyzed two such symmetry methods

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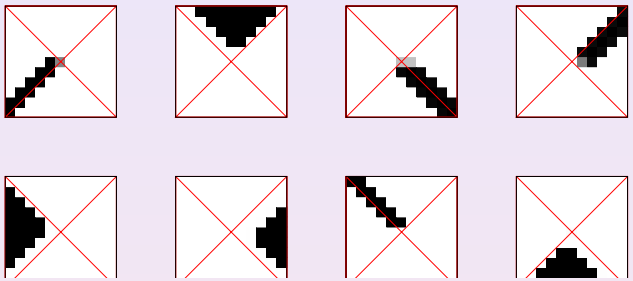

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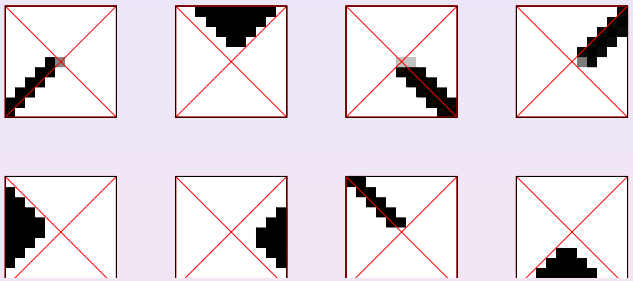

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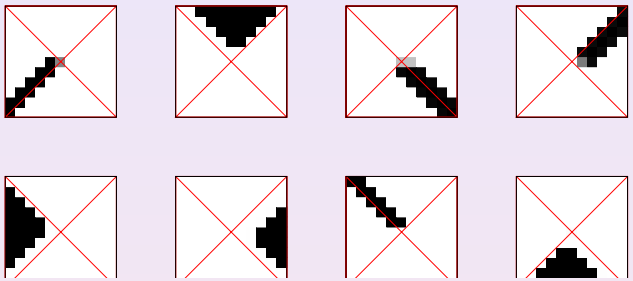

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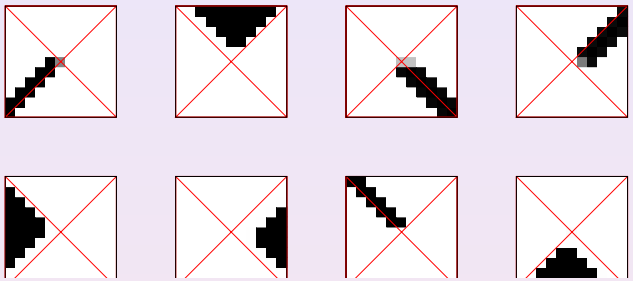

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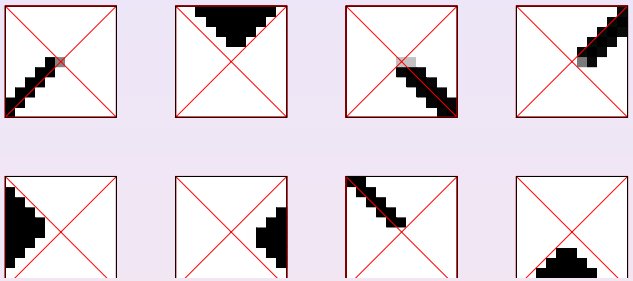

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- Consider a concept $(R = \mathbb{Z}^2, Y)$ with e.g. $Y = M$ or $Y = S$.
- Perform on R all (infinite-grid) symmetry operations $\xi^{\theta,\varphi,x_0,y_0} : \mathbb{Z}^2 \to \mathbb{Z}^2$ with $\xi^{\theta,\varphi,x_0,y_0} := \xi^{x_0,y_0}_{\text{trans}} \circ \xi^{\varphi}_{\text{rot}} \circ \xi^{\theta}_{\text{mir}}$
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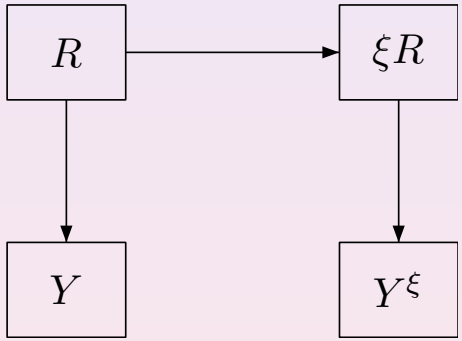

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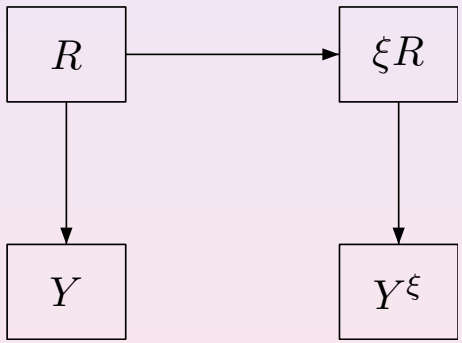

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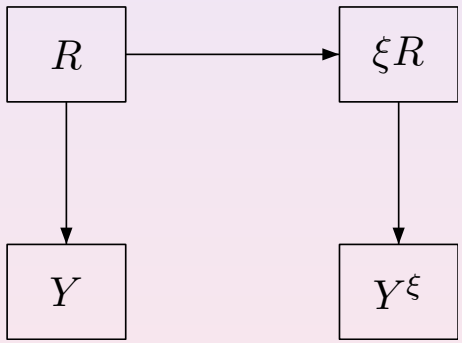

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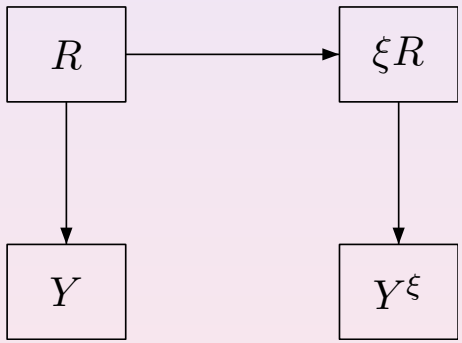

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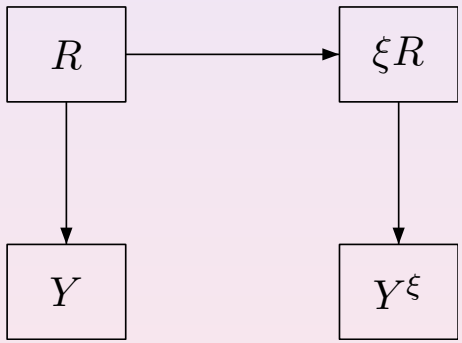

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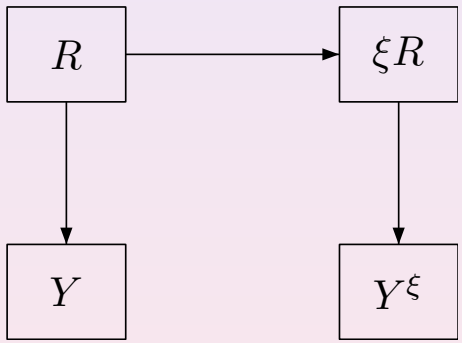

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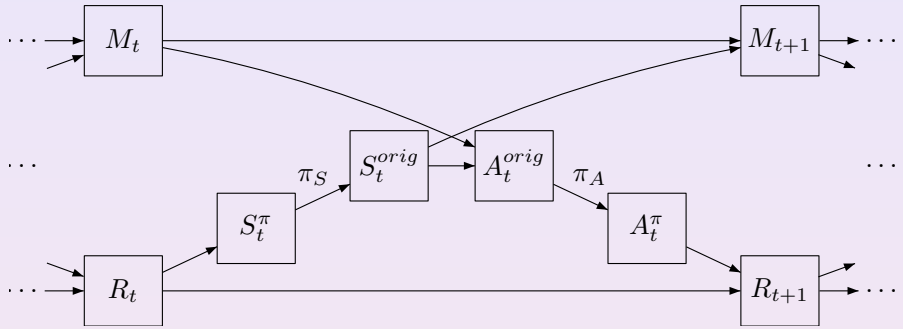
Intrinsic Symmetry

- Consider a "permutation of the embodiment" of the agent:



- With each permutation pair (π_S, π_A) the agent generates a different concept (R_0, M_{15}^{π}).
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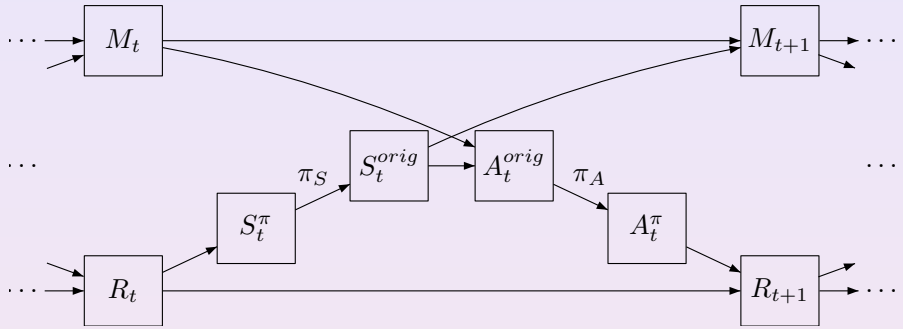

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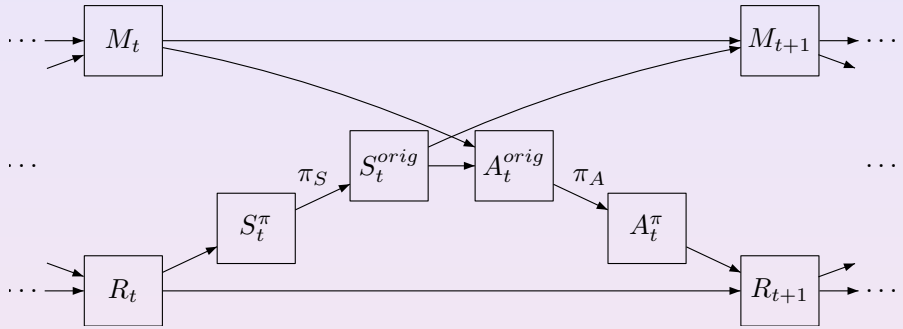

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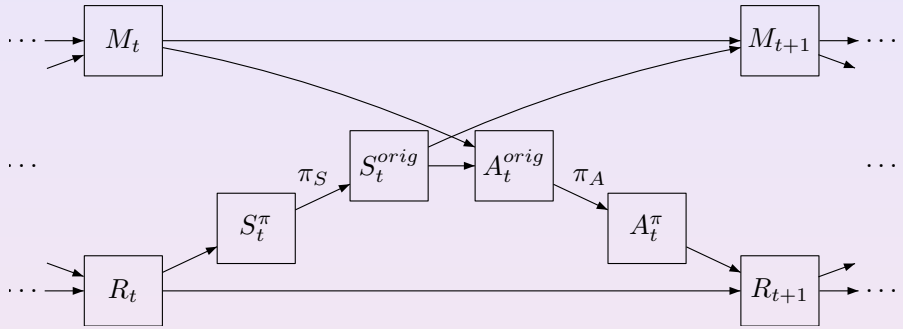

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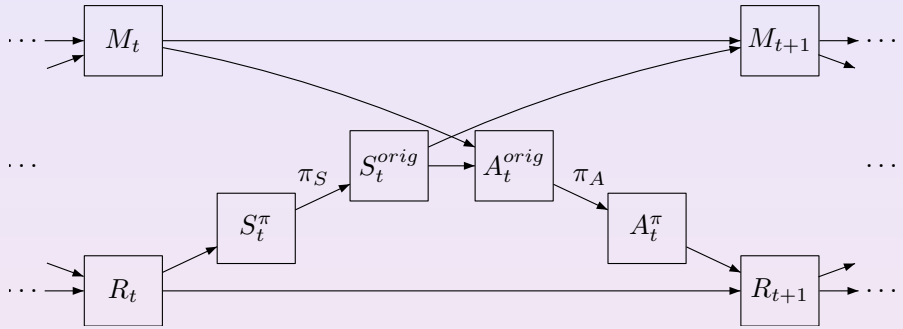

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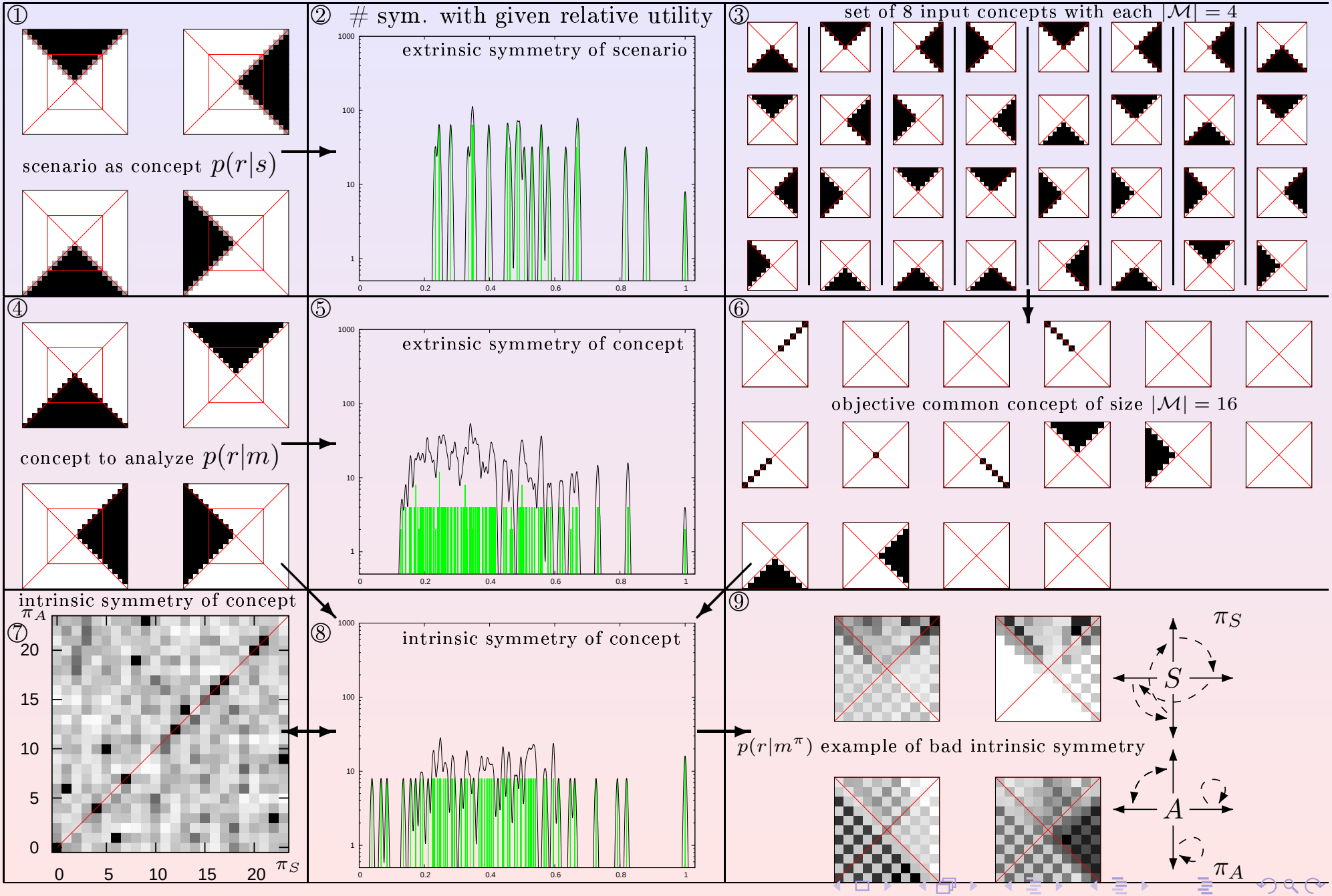
Results Scenario s+



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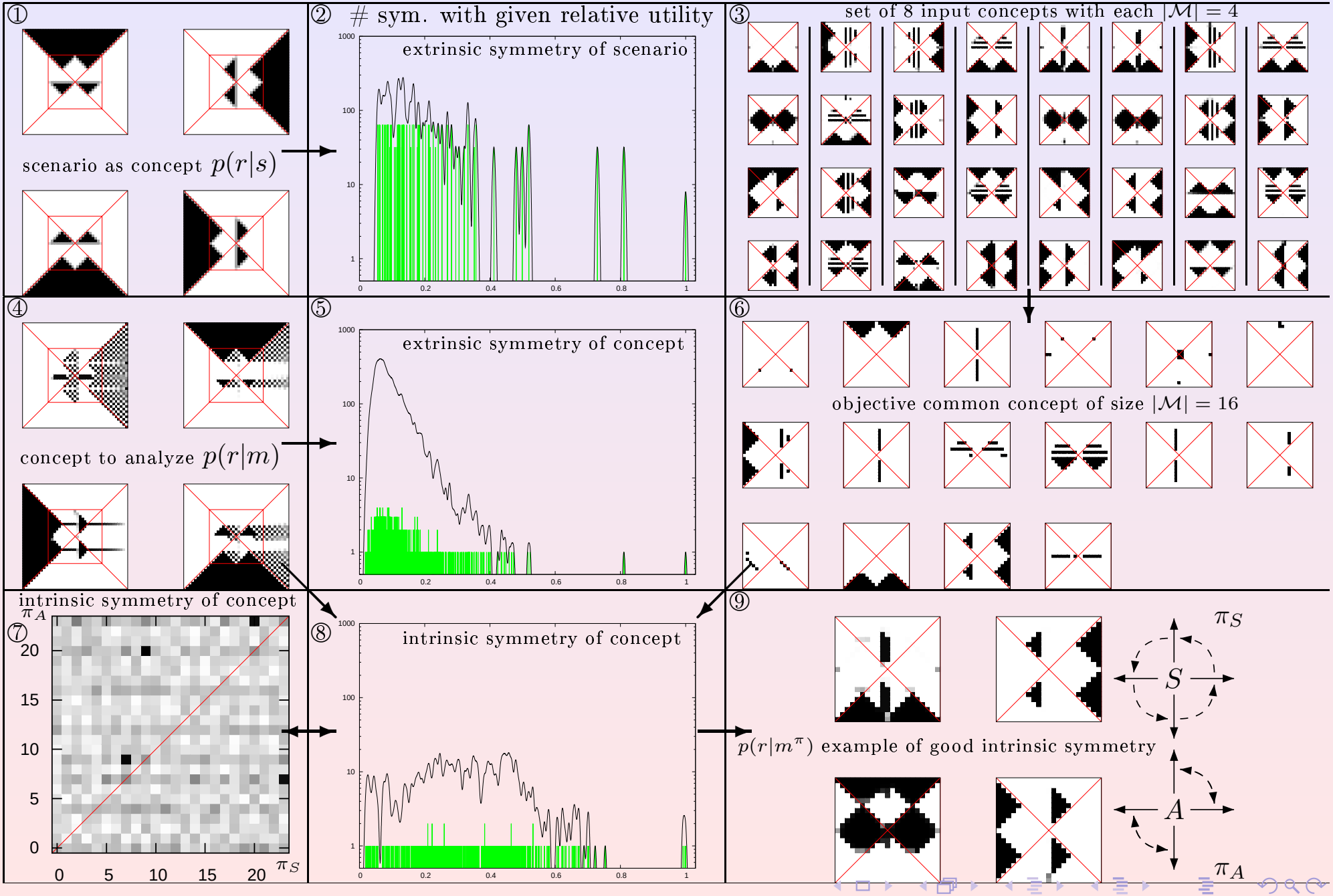
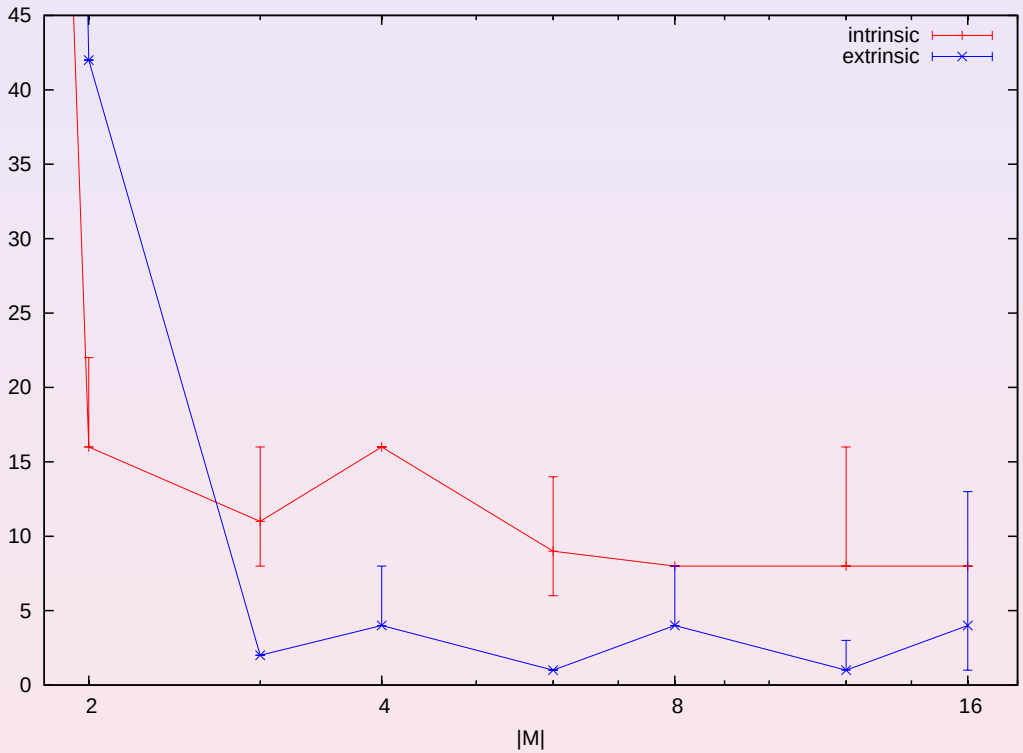


Number of Symmetries vs. Agent Memory Size



Amount of good (82,5% | 85% | 87.5% of max utility) intrinsic and extrinsic symmetries in memory size $|\mathcal{M}|$ dependence.

Questions?

http://www.xkcd.org/166