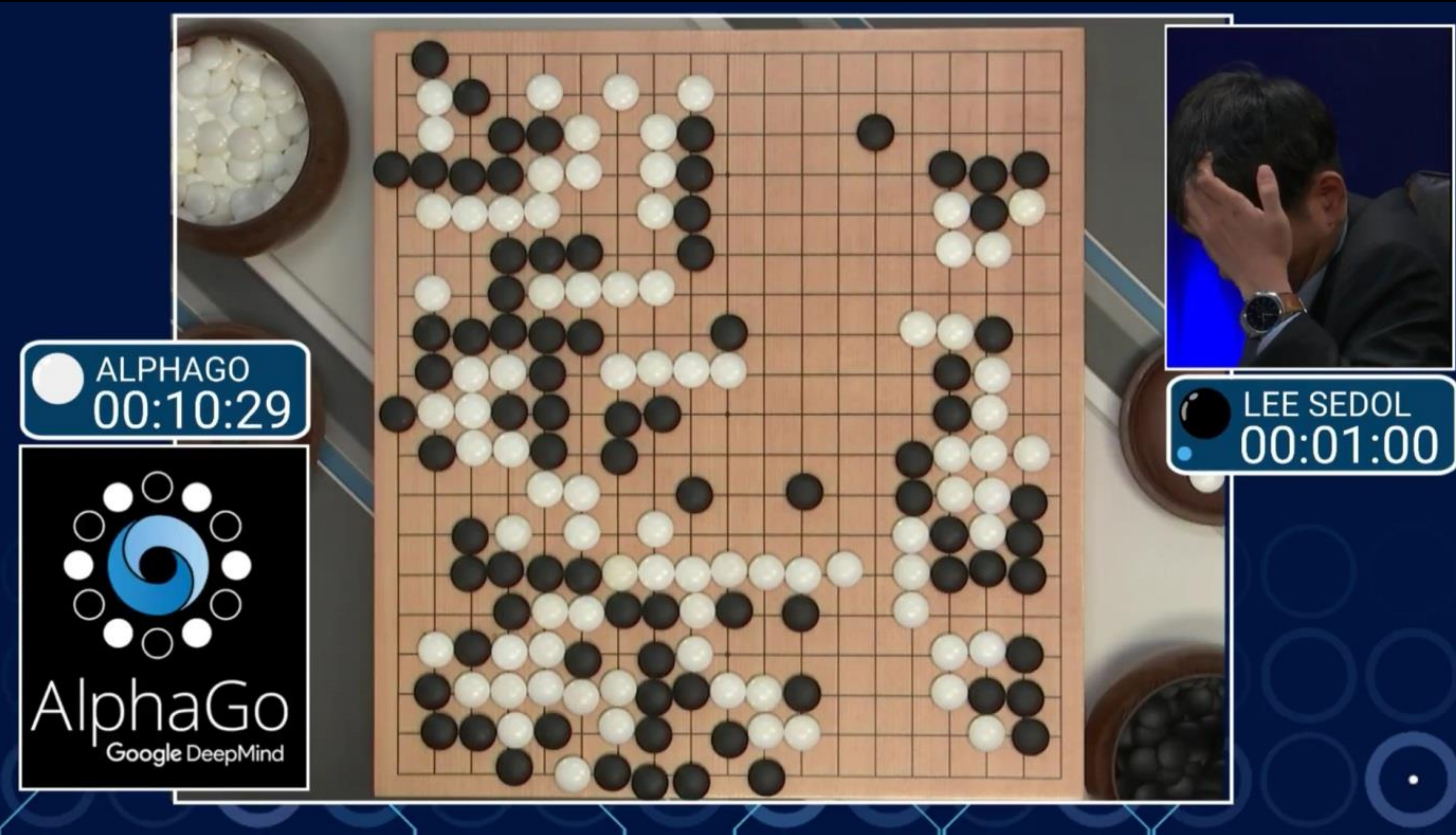
Aristo: Allen AI Challenge

Jeroen Craps
Jorik De Waen

1996: Deep Blue

VS

2016: AlphaGo



https://www.engadget.com/2016/03/12/watch-alphago-vs-lee-sedol-round-3-live-right-now/

Are these computers smarter than humans?

Are these computers INTELLIGENT?

Turing test

Inventor: Alan Turing

Year: 1950

Test: Convince a human that it is chatting with another human instead of a computer

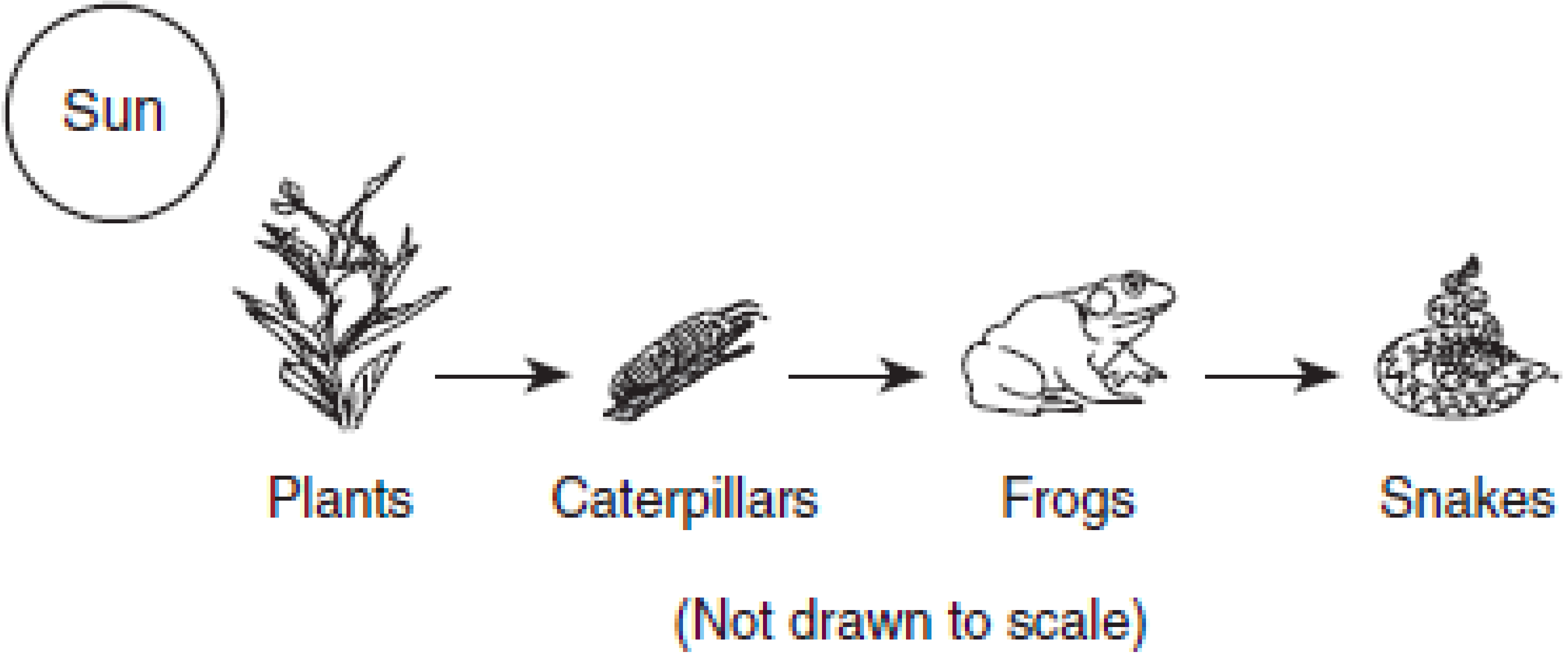
https://xkcd.com/329/

If a computer can
solve the Turing test,
is it truly intelligent?

If a computer can
solve the Turing test,
is it truly intelligent?

No.

An example



If the population of snakes increases, the population of frogs will most likely

(A) decrease
(B) increase
(C) remain the same

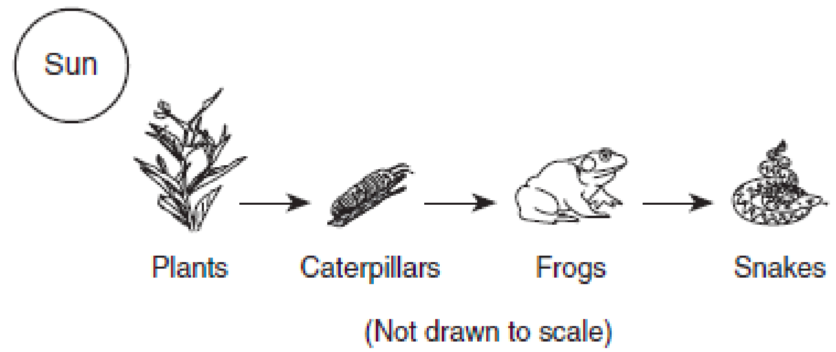
http://aristo-demo.allenai.org

An example

Target: 4th grader

Goal: Interpreting a figure and world modelling

Problem: Not factoid questions and requires language understanding



If the population of snakes increases, the population of frogs will most likely

(A) decrease
(B) increase
(C) remain the same

New pillars

VARIETY

COMPLEX

COMMONSENSE

SCALABLE

Why 4th grade tests?

Measurable ✓

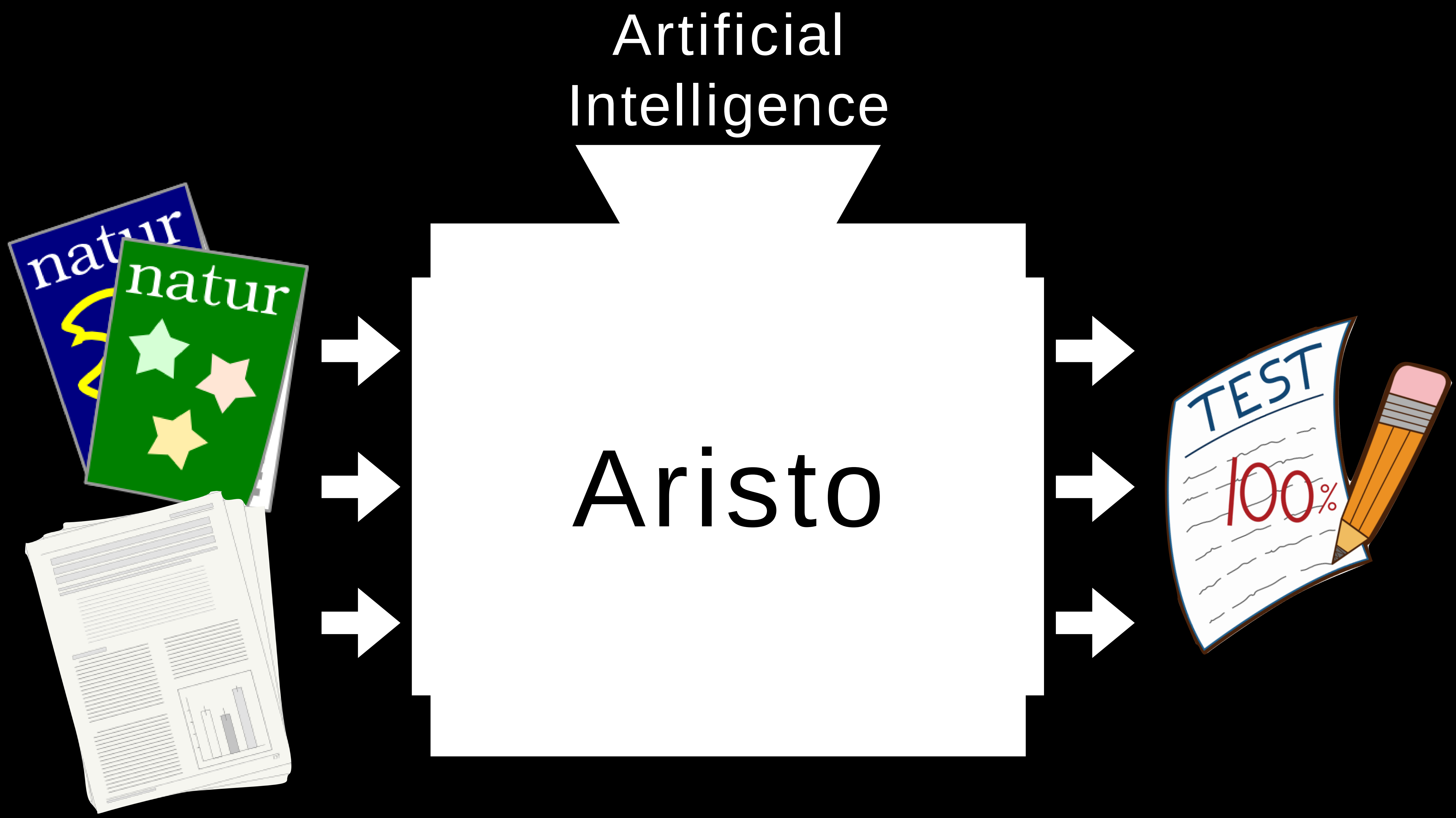
Graduated ✓

Not game-able ✓

Ambitious
but realistic ✓

Motivating ✓

Tackling the problem



1.
IMAGE
RETRIEVAL

2.
TEXT-BASED
KNOWLEDGE
EXTRACTION

PDFFigures2.0

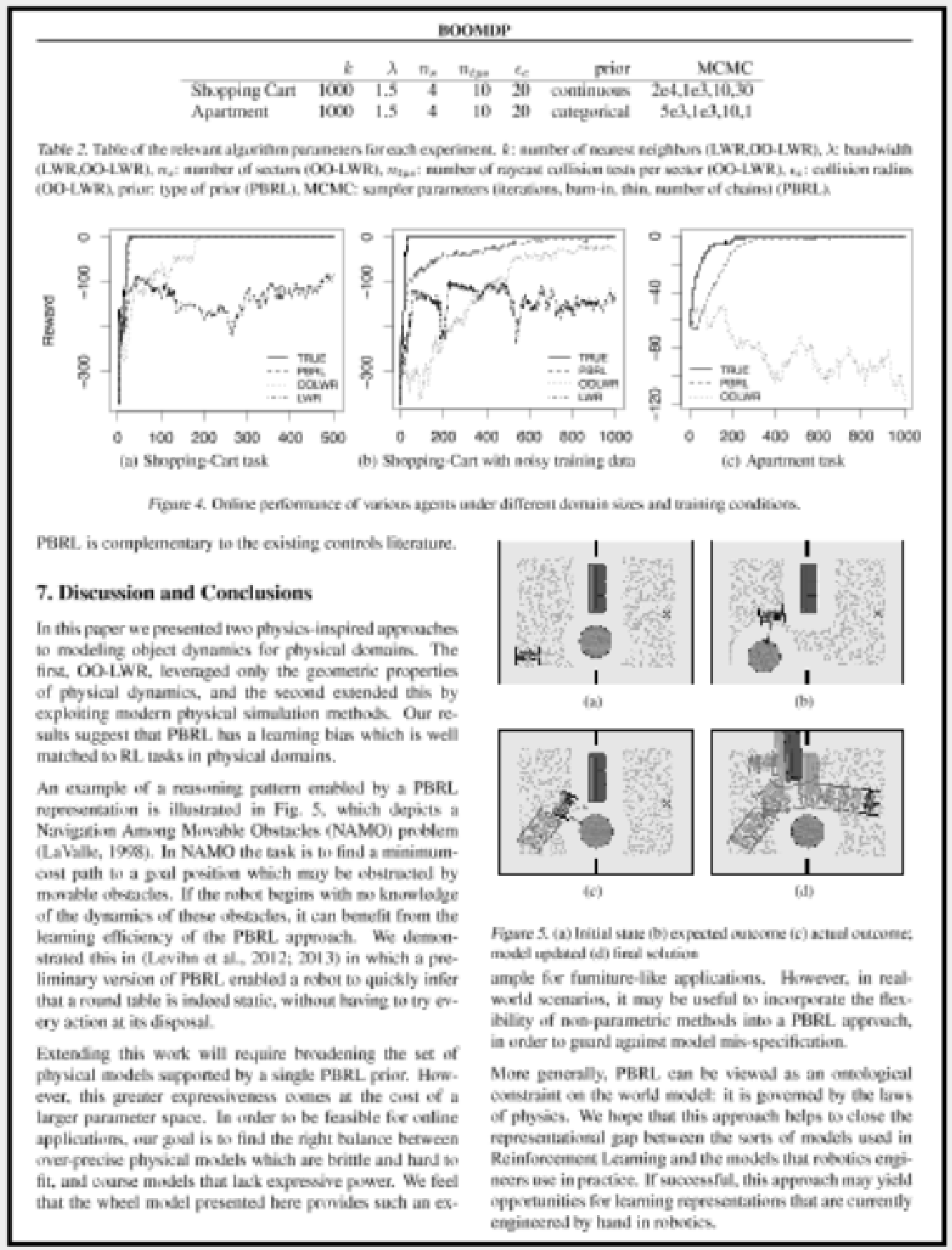
Input: Scientific papers

Step 1: Find the caption (keywords)
↳Removing false positives (filters)

Step 2: Classify regions and text

Step 3: Assign captions with titles
through clustering

PDFFigures2.0 (Result)



	k	λ	n_s	n_{tps}	ϵ_c	prior	MCMC
Shopping Cart	1000	1.5	4	10	20	continuous	2e4,1e3,10,30
Apartment	1000	1.5	4	10	20	categorical	5e3,1e3,10,1

Table 2. Table of the relevant algorithm parameters for each experiment. k: number of nearest neighbors (LWR,OO-LWR), λ: bandwidth (LWR,OO-LWR), n_s: number of sectors (OO-LWR), n_{tps}: number of raycast collision tests per sector (OO-LWR), ϵ_c: collision radius (OO-LWR), prior: type of prior (PBRL), MCMC: sampler parameters (iterations, burn-in, thin, number of chains) (PBRL).

(a) Shopping-Cart task (b) Shopping-Cart with noisy training data (c) Apartment task

Figure 4. Online performance of various agents under different domain sizes and training conditions.

PBRL is complementary to the existing controls literature.

7. Discussion and Conclusions

In this paper we presented two physics-inspired approaches to modeling object dynamics for physical domains. The first, OO-LWR, leveraged only the geometric properties of physical dynamics, and the second extended this by exploiting modern physical simulation methods. Our results suggest that PBRL has a learning bias which is well matched to RL tasks in physical domains.

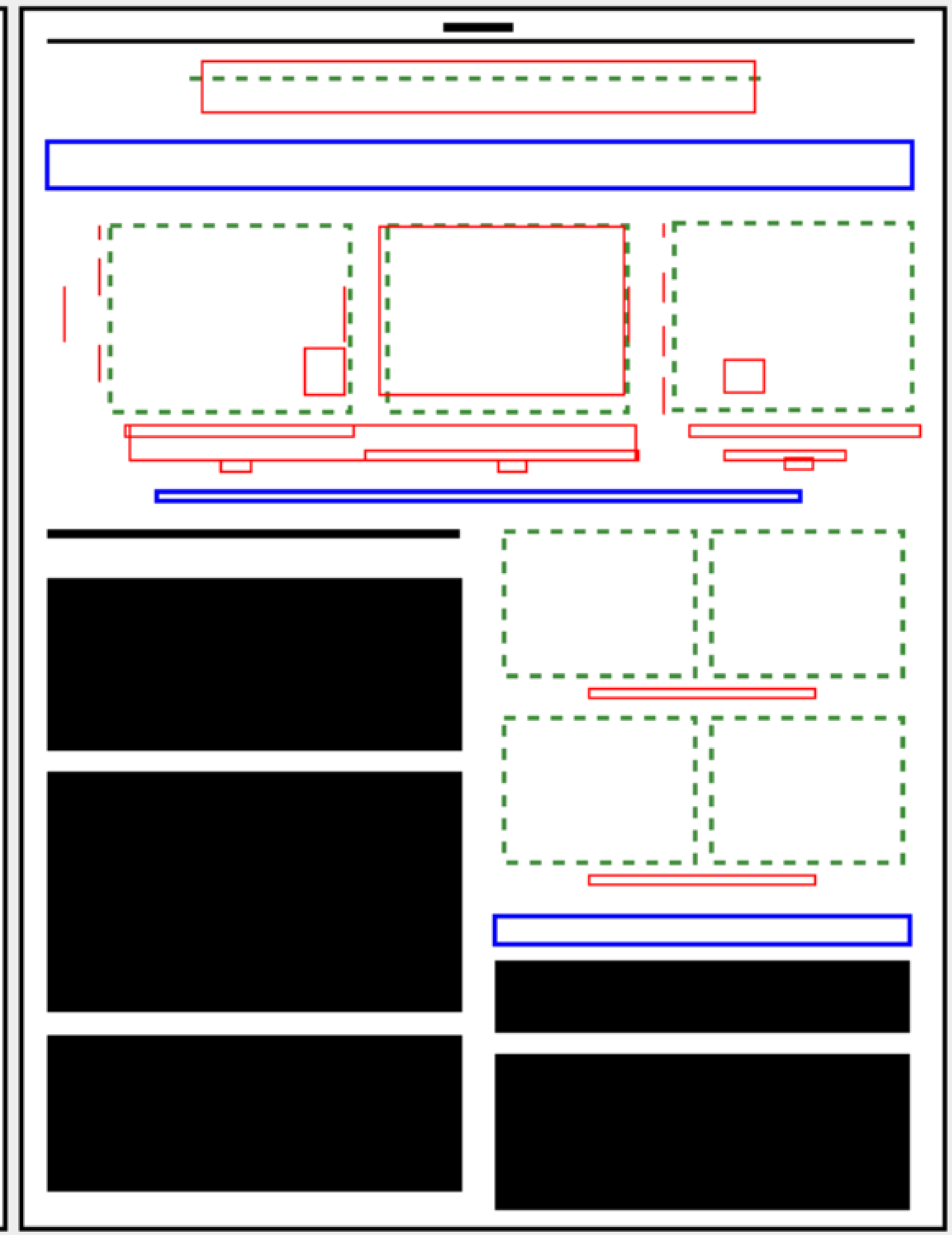
An example of a reasoning pattern enabled by a PBRL representation is illustrated in Fig. 5, which depicts a Navigation Among Movable Obstacles (NAMO) problem (LaValle, 1998). In NAMO the task is to find a minimum-cost path to a goal position which may be obstructed by movable obstacles. If the robot begins with no knowledge of the dynamics of these obstacles, it can benefit from the learning efficiency of the PBRL approach. We demonstrated this in (Levihn et al., 2012; 2013) in which a preliminary version of PBRL enabled a robot to quickly infer that a round table is indeed static, without having to try every action at its disposal.

Extending this work will require broadening the set of physical models supported by a single PBRL prior. However, this greater expressiveness comes at the cost of a larger parameter space. In order to be feasible for online applications, our goal is to find the right balance between over-precise physical models which are brittle and hard to fit, and course models that lack expressive power. We feel that the wheel model presented here provides such an example for furniture-like applications. However, in real-world scenarios, it may be useful to incorporate the flexibility of non-parametric methods into a PBRL approach, in order to guard against model mis-specification.

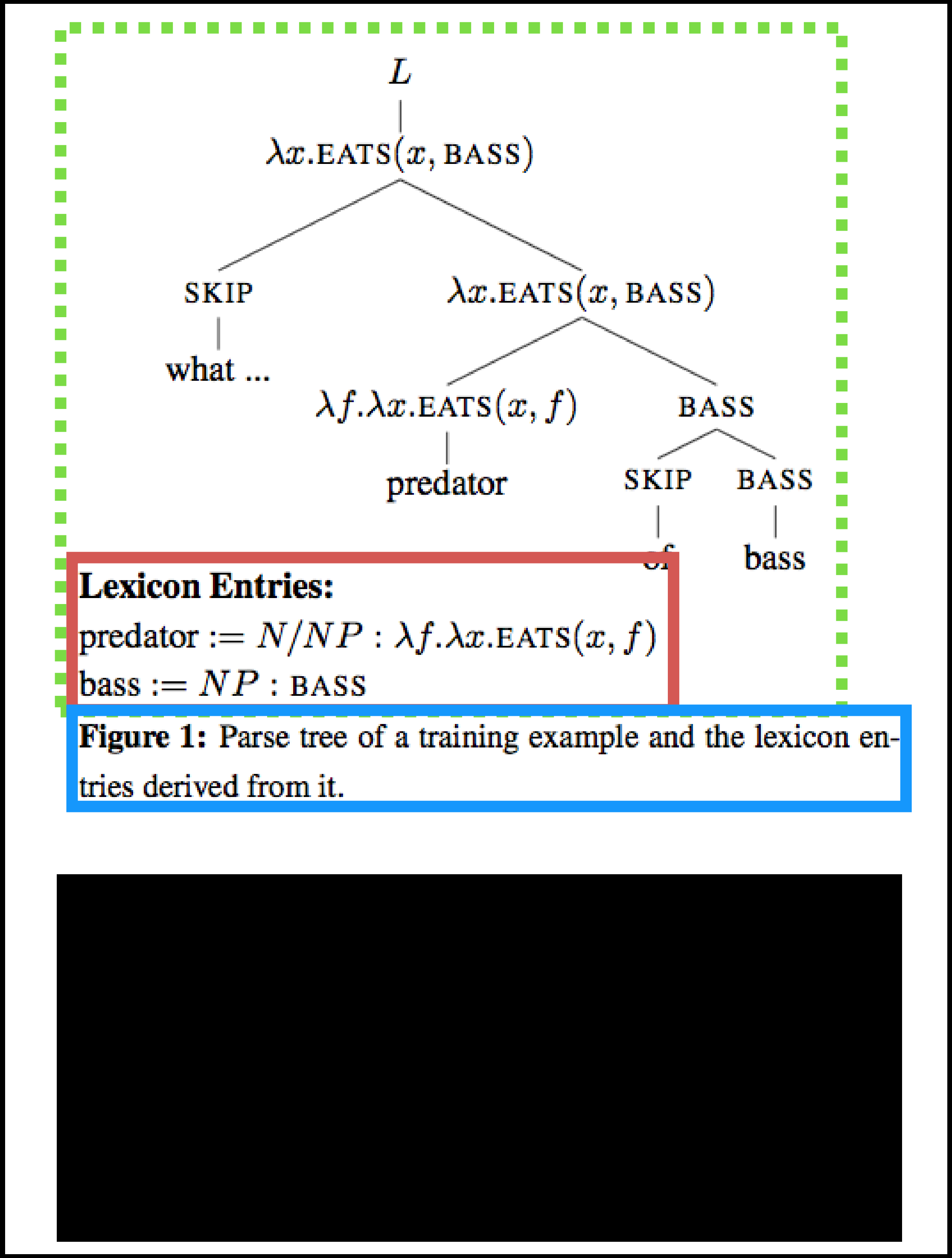
(a) (b) (c) (d)

Figure 5. (a) Initial state (b) expected outcome (c) actual outcome; model updated (d) final solution

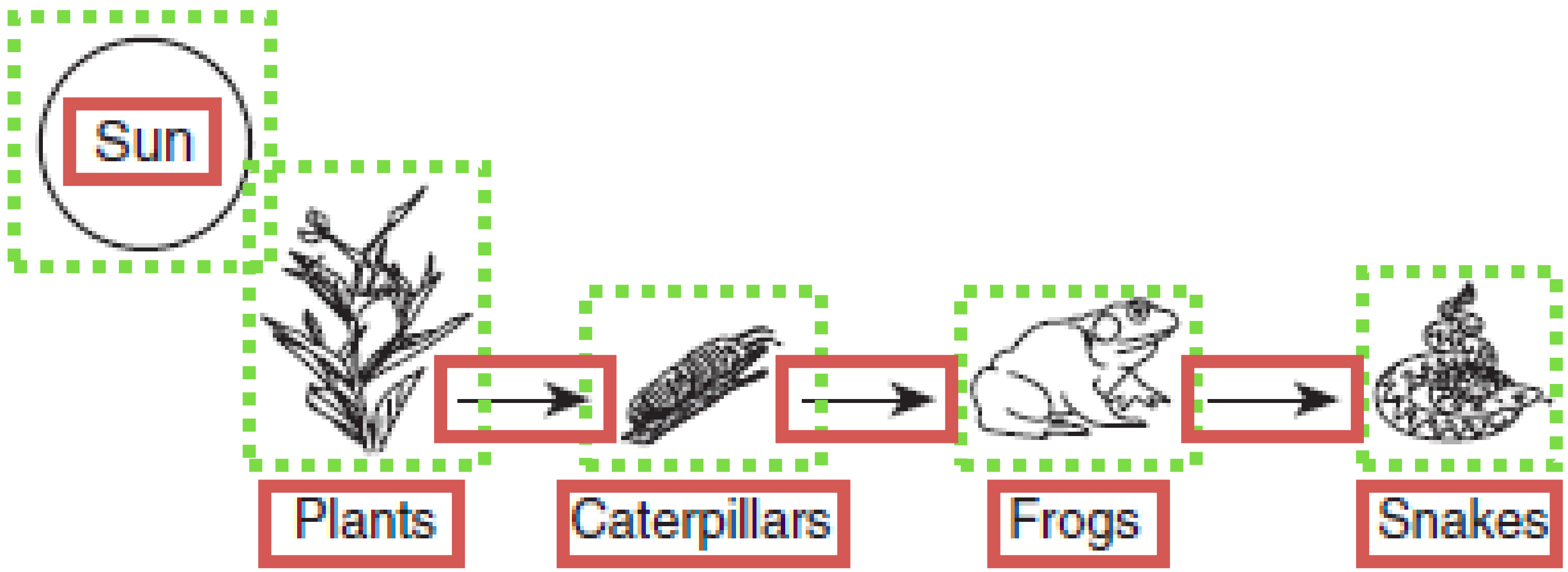
More generally, PBRL can be viewed as an ontological constraint on the world model: it is governed by the laws of physics. We hope that this approach helps to close the representational gap between the sorts of models used in Reinforcement Learning and the models that robotics engineers use in practice. If successful, this approach may yield opportunities for learning representations that are currently engineered by hand in robotics.



PDFFigures2.0



An example (Cont'd)



(Not drawn to scale)

If the population of snakes increases, the population of frogs will most likely

(A) decrease
(B) increase
(C) remain the same

http://aristo-demo.allenai.org

Text-based knowledge extraction

Input: 4th grade text books

Step 1: Match patterns with text to find relations between concepts

Step 2: Translate matched patterns (+ variants) to formal logic language

Step 3: Store knowledge as logical statements in knowledge base

Example

“Mechanical energy is produced when two objects move together.”

⬇

("two objects"/?x "produce" "Mechanical energy")
"when“ /CONDITION
("two objects"/?x "move" "" ["together"])

⬇

forall m, t, o
isa(m,"move"), isa(t,"together"), isa(o,"two objects"), agent(m,o), arg(m,t)
-> exists p, e
isa(p,"produce"),isa(e,"Mechanical energy"), agent(p,o), object(p,e), condition(p,m).

Answering questions

1

What is the meaning of the question?

2

What is the correct answer?

1) What is the meaning of the question?

- A question == A query for some piece of data
- Goal: Construct a logical query that matches the question
- One approach: Attempt to reconstruct the question from possibly logical queries

Training the model

Training Example:

$$\mathbf{w} = \text{What is the predator of bass ?}$$
$$L = \{\lambda x.\text{EATS}(x, \text{BASS}),$$
$$\lambda x.\text{CAUSE}(\text{INCREASE}(\text{BASS}), \text{INCREASE}(x)),$$
$$\ldots\}$$

Generated Grammar:

Unary rules:

$L \rightarrow \lambda x.\text{EATS}(x, \text{BASS})$

$L \rightarrow \lambda x.\text{CAUSE}(\text{INCREASE}(\text{BASS}), \text{INCREASE}(x))$

Nonterminal rules:

$\lambda x.\text{EATS}(x, \text{BASS}) \rightarrow \text{BASS} \;\; \lambda f.\lambda x.\text{EATS}(x, f)$

$\lambda x.\text{EATS}(x, \text{BASS}) \rightarrow \lambda f.\lambda x.\text{EATS}(x, f) \;\; \text{BASS}$

$\text{BASS} \rightarrow \text{SKIP} \;\; \text{BASS}$

...

Terminal rules:

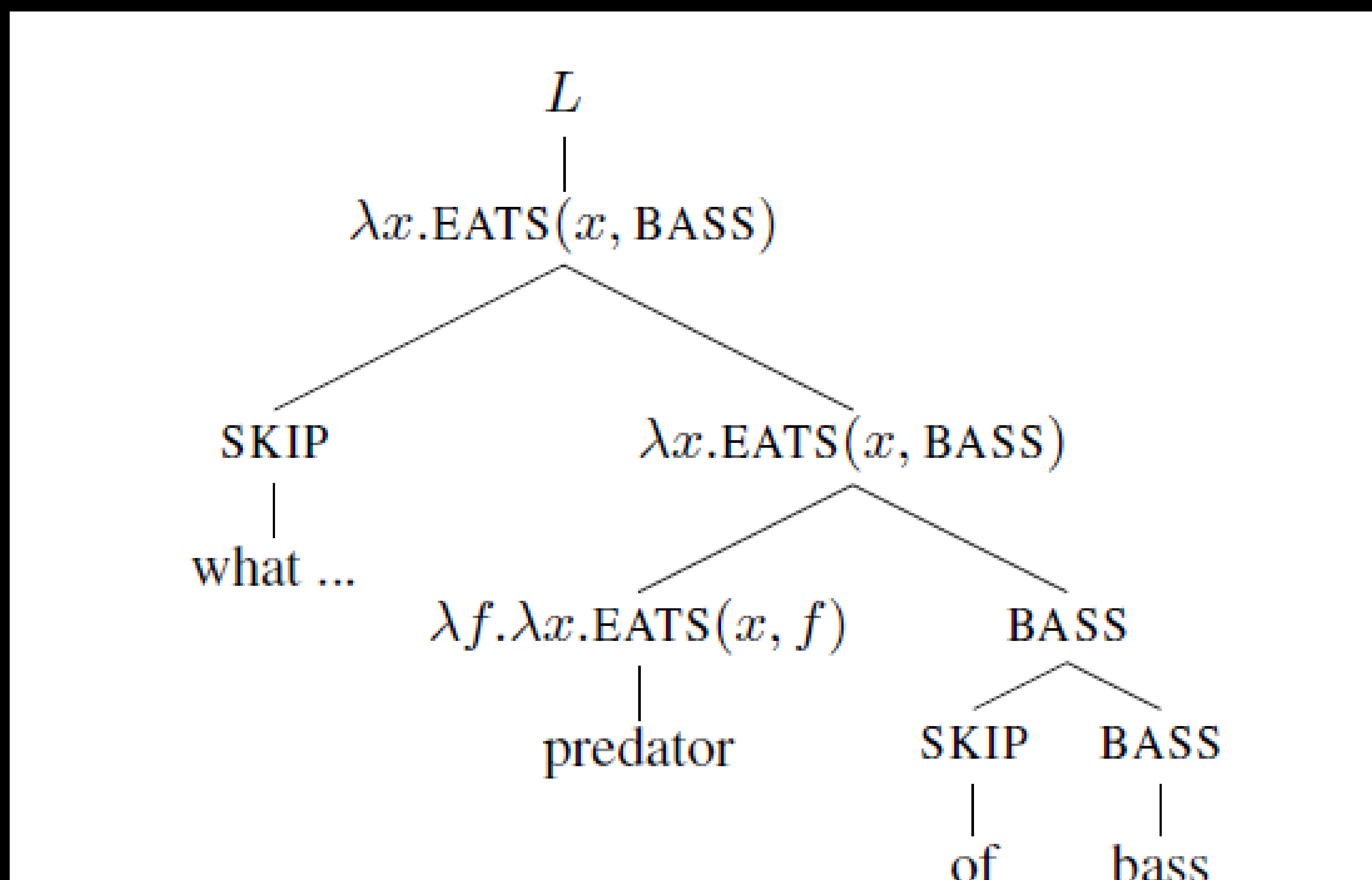
$\lambda x.\text{EATS}(x, \text{BASS}) \rightarrow$ what

$\lambda x.\text{EATS}(x, \text{BASS}) \rightarrow$ is

$\text{SKIP} \rightarrow$ what

...

Applying the model



2) What is the correct answer?

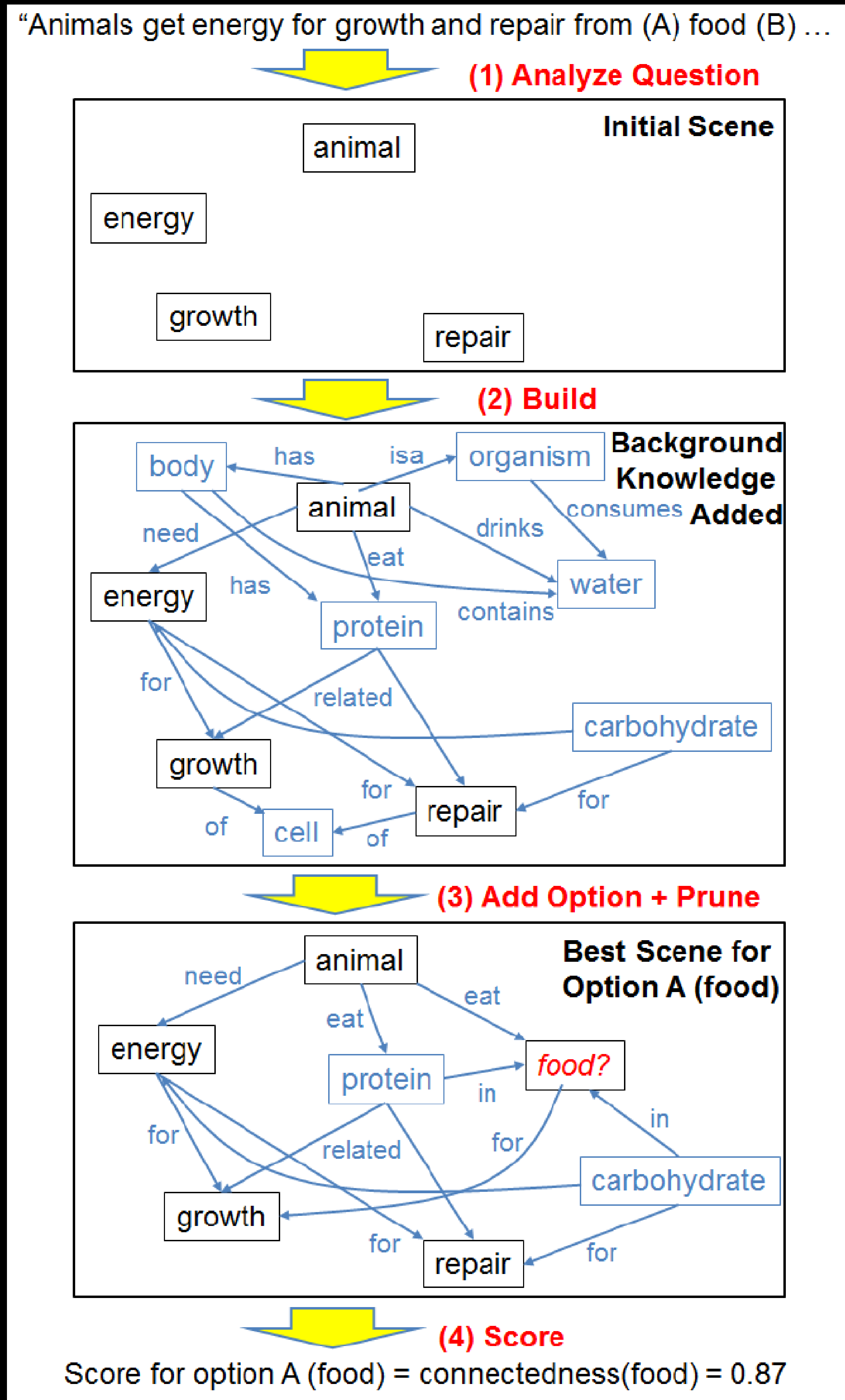
Input: A multiple-choice question

Step 1: Analyse the question and find important concepts

Step 2: Add background knowledge from knowledge base to form a graph

Step 3: Add option and prune graph

Step 4: Score option based on cohesion within knowledge graph


"Animals get energy for growth and repair from (A) food (B) …
(1) Analyze Question
Initial Scene
animal
energy
growth
repair
(2) Build
Background Knowledge Added
body
has
isa
organism
animal
consumes
need
drinks
eat
water
energy
has
protein
contains
for
related
carbohydrate
growth
for
repair
for
of
cell
of
(3) Add Option + Prune
Best Scene for Option A (food)
animal
need
eat
eat
energy
protein
food?
in
in
for
for
related
carbohydrate
growth
for
repair
for
(4) Score
Score for option A (food) = connectedness(food) = 0.87

DEMO

http://aristo-demo.allenai.org