Artificial Intelligence Reading Club

Chapter 04

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Beyond the Octopus: From General Intelligence toward a Human-like Mind

1 Octopus Intelligence

2 A "Ladder" of Intelligence

3 Implications of the Ladder for AGI

1. Octopus Intelligence

AGI

A digital system including
multi-strategy problem solving,
spatial reasoning,
rich sensory perception in
multiple modalities,
complex motor control,
tool usage,
theory-of-mind
consciousness...

can do

Octopus

1. Octopus Intelligence

About Octopus

(1) Habits

The common octopus lives from 12 to 18 months. The octopus disperse quickly after birth and seldom encounter others of their species until they eventually mate.

A mature female mates lays tens of thousands of eggs and dies soon thereafter.

The hatchlings spend 45 to 60 days floating in ocean currents and feeding in the plankton layer.

The small proportion that survive this stage begin a bottom dwelling life in the sea floor.

(2) Physical features

The typical adult octopus has a relatively large brain, estimated at 300 million neurons.

The ratio of octopus brain to body mass is more similar to birds and mammals.

Each arm has smaller, mostly independent neural systems (about 50 million neurons each)

Sensory and motor function is neatly separated into a series of well-defined lobes...

1. Octopus Intelligence

How smart are the octopuses?

Opening a screw top jar
A five-month-old female octopus learned to open screw-top jars by watching human hands do the same task.

Using coconut halves as portable shelters
An octopus in Indonesia excavates a half of a coconut, crawls into one half and pulls the other over itself to hide from predators.

Shooting out the lights
 An octopus had learned to shoot out the 2000 Watt spot light above him with a carefully directed jet of water.

1. Octopus Intelligence

How smart are the octopuses?

Spatial learning
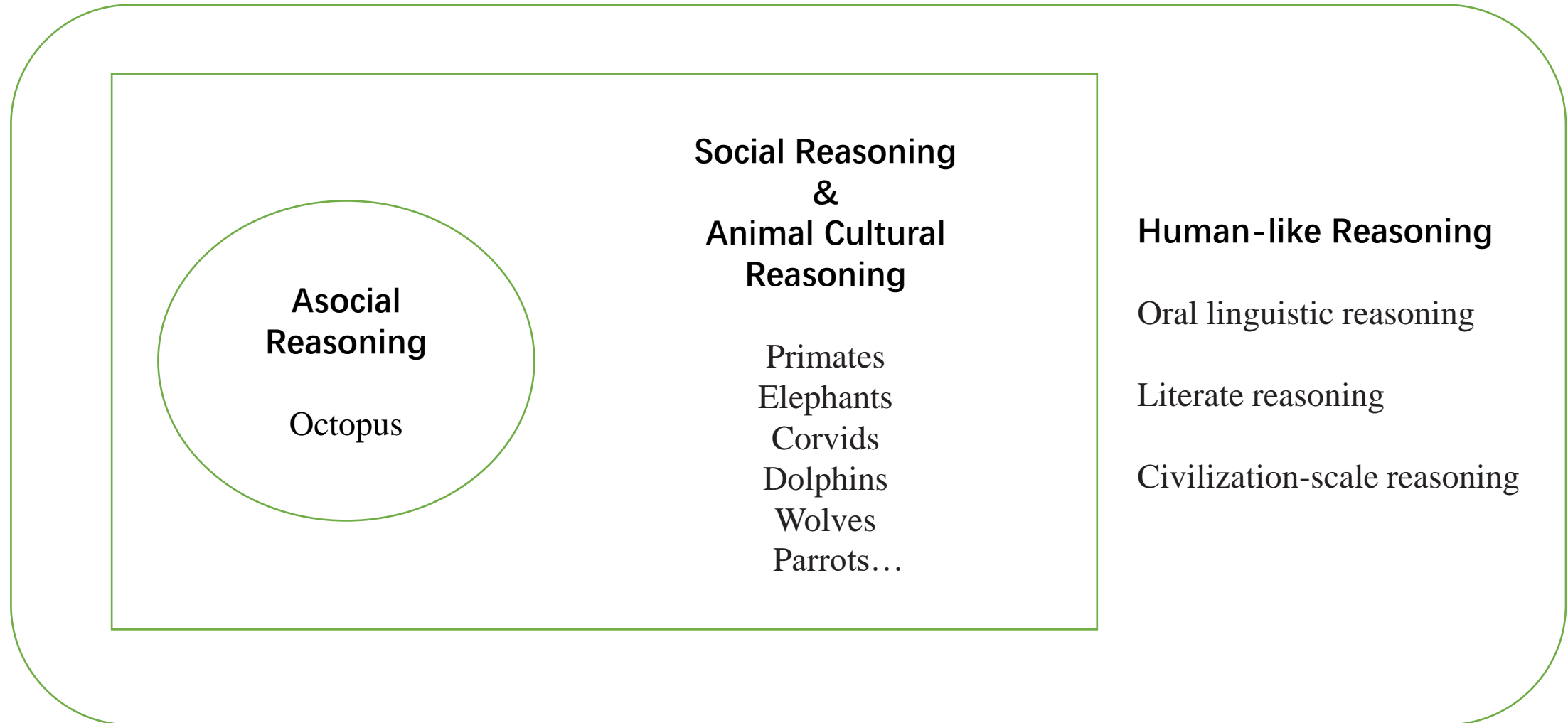Octopuses learn maps of the territory in which they hunt.

Observational learning
The captive octopuses can learn to choose the "correct" colored ball from a pair placed in their tank by observing other octopuses trained to do the task.

Camouflage and behavioral mimicry
A few species of octopus also disguise themselves by mimicking the shape and movements of other animals in their environment.

2. A "Ladder" of Intelligence

Asocial Reasoning

Octopus

Social Reasoning
&
Animal Cultural Reasoning

Primates
Elephants
Corvids
Dolphins
Wolves
Parrots…

Human-like Reasoning

Oral linguistic reasoning

Literate reasoning

Civilization-scale reasoning

2. A "Ladder" of Intelligence

Asocial Rung

Hide, forage, hunt, kill, flee, eat, what and *where...*
To properly interpret such words requires some "gut-level" grounding on the asocial rung.

Social Rung

Nurture, protect, feed, bond, give, and *share...*

Non-linguistic Animal Cultural Rung

Follow, cooperate, play, lead, warn, trick, steal (as opposed to simply *take*), and *teach* (in the sense of interacting in a way designed to maximize its teaching value) …

2. A "Ladder" of Intelligence

Oral Linguistic Rung

Promise, apologize, oath, agree, covenant, name (as in a person's name or the name of an object or place), *faith, god, game, gamble, plan, lie* (or *deceive*), *ritual, style, status, soul, judge, sing, clothing* (hence *nakedness*), and above all *why...*

Literate Rung

Library, contract, fiction, technology, essay, spelling, acronym, document, and *book*

Civilization-scale Abstract Concepts

democracy, empire, philosophy, science, mathematics, culture, economy, nation, literature...

3. Implications of the Ladder for AGI

About Ontology

(1) Reason
Each rung of the ladder places unique requirements on knowledge representation and the ontologies required for reasoning at that level.

(2) Definition
The term ontology is used to describe the organization of the internal artifacts of mental existence in an intelligent system or subsystem, including an AGI system.

(3) Purpose
It is not our goal here to define a specific ontology for an AGI.
We seek to explore the implications of the different design choices faced by researchers seeking to develop AGI systems.

3. Implications of the Ladder for AGI

Asocial ontologies

Humans have some abilities in common with many asocial animals.

In humans, the rungs are not as separable as AGI researchers might wish.

Because humans learn them over many years in the midst of other simultaneously operating rungs, the ontological categories inevitably become intertwined in ways difficult to disentangle.

Social ontologies

Social interaction provides a richer learning experience than does hatching into an asocial existence.

social animals must learn how to communicate with others of their species.

The human version of such primitive social behavior includes social dominance and submission signals, group membership awareness, predator awareness and warnings.

3. Implications of the Ladder for AGI

Cultural ontologies

- The most intelligent social species *actively teach* their young, passing on information via structured and emotive utterances(proto-languages).
- Human versions of the animal cultural rung are quite similar to the animal version when the knowledge to be transferred is not well suited to verbal description.
- It may be strategically important for AGI researchers to first learn to build a primitive social AGI. (There are two reasons)

Oral linguistic ontologies

Human language facilitates an explosion of concepts which at this level are more appropriately called memes. [approximates the notion of a concept, often but not necessarily expressible in words.]

Language in primary oral societies uses a more complex and idiosyncratic syntax than written language.

AGI researchers will need to be exceedingly careful to properly develop an oral language human-level AGI because academics are so thoroughly steeped in literate intelligence.

3. Implications of the Ladder for AGI

Literate ontologies

Literacy exposes people to a wider variety of memes than does an oral culture.

What must be added to the ontology or the reasoning skills of an oral-language AGI to support literacy.

Civilization-scale ontologies

Over the longer term and wider geography, literacy and other persistent forms of human knowledge can affect large numbers of people who combine and recombine ideas (memes) in new ways to form new memes.

Humanity collectively reasons about the world in slow, subtle and unobservable ways, and not necessarily with the help of literacy.

The ontological requirements for supporting intelligence at this level are largely unexplored.

Thank you for your time!