Relational Epistemology of Biological Agency with Artifactual Scaffold

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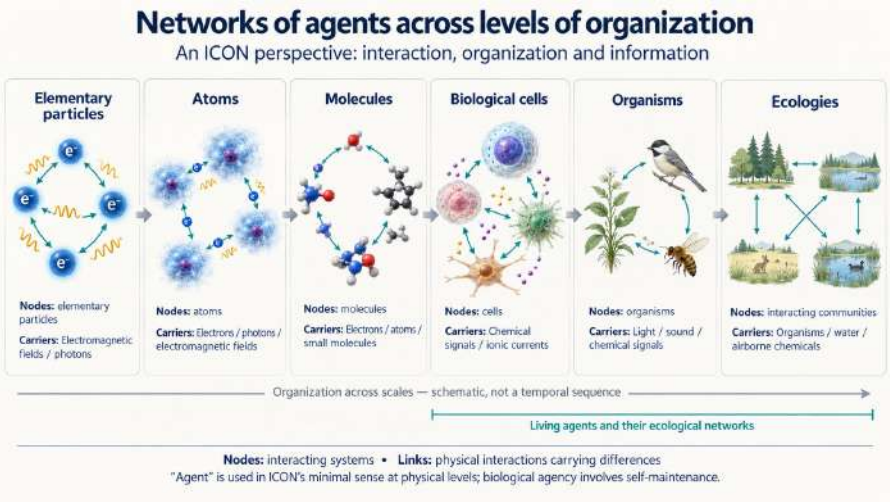
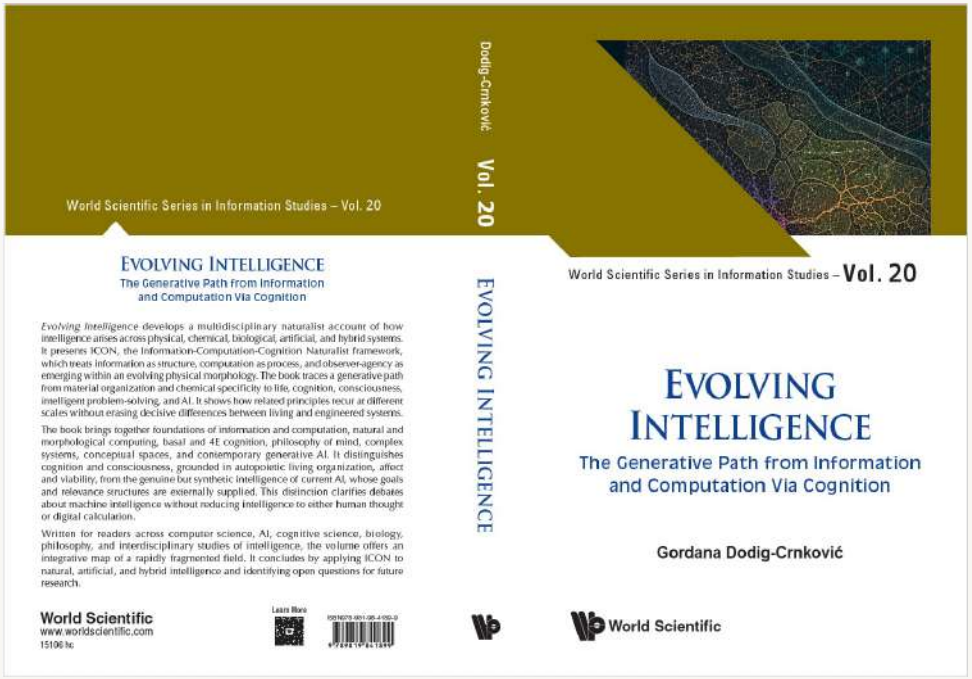
SWECOG 2026
Ångström Laboratory, Uppsala University, October 26 – 28

ICON: Information-Computation-Cognition Naturalism

ICON framework describes nature as networks of networks of interacting observer-agents, from elementary particles, to atoms, molecules, cells, organisms and ecologies where informational structures change through processes of physical computation.





The observer-agent in ICON

Information-Computation-Cognition Naturalism

Information and computation

Information is a difference that matters for a system (structure).
Computation transforms informational structure (process) through
physical processes of morphological transformation.

Observer-agent

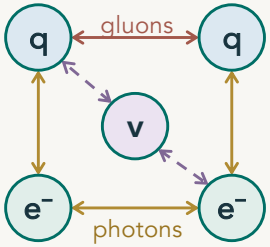
The observer-agent is a participatory node in a network of interacting agents.
This minimal sense of agency includes simplest physical systems.
Registers differences through changes in its own state
and affects other systems through its subsequent changes.

Bateson (1972); Dodig-Crnkovic (2017, 2025, forthcoming 2027)

Networks of agents across levels of organization in nature

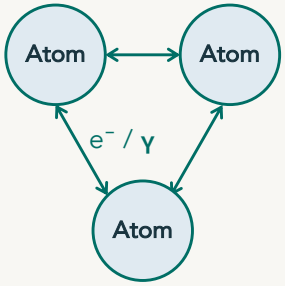
An ICON perspective: interaction, organization and information

Elementary particles



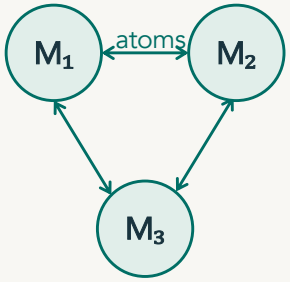
Nodes: particles
Interaction Carriers
EM: photons
Strong: gluons
Weak: W and Z
Gravity: gravitons*

Atoms



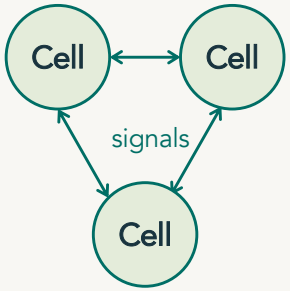
Nodes: atoms
Carriers
Electrons / photons
Interaction
Electromagnetic

Molecules



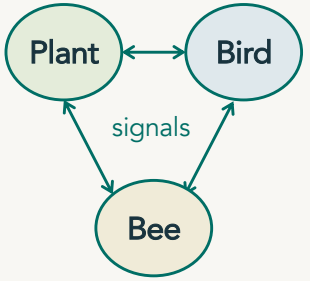
Nodes: molecules
Carriers
Electrons / atoms
Small molecules

Biological cells



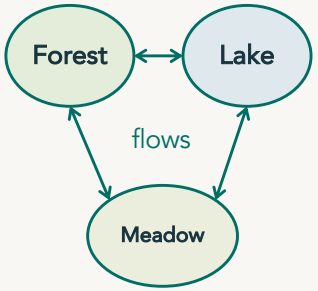
Nodes: cells
Carriers
Chemical signals
Ionic currents
Autopoietic systems

Organisms



Nodes: organisms
Carriers
Light / sound
Chemical signals

Ecologies



Nodes: communities
Carriers
Organisms / water
Airborne chemicals

Organization across scales (schematic, not a temporal sequence)

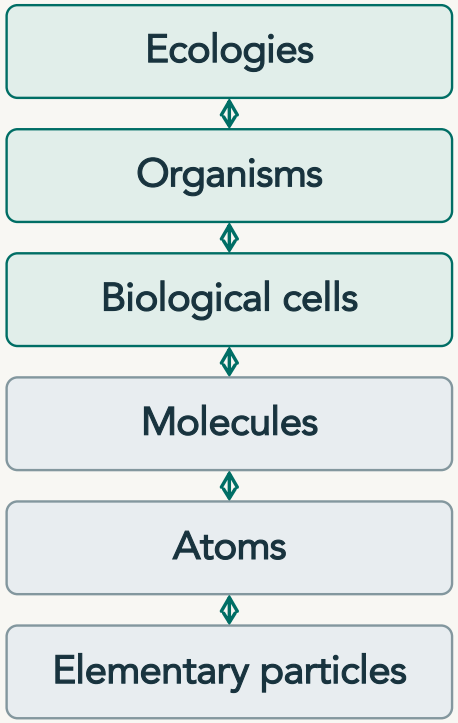
Biological agency: autopoiesis (self-production and self-maintenance). Evolution occurs across generations in populations and lineages.

Nodes denote interacting systems. Links denote physical interactions carrying differences. "Agent" has ICON's minimal sense at physical levels.

*Gravitons are hypothetical and undetected. Force mediators: CERN, The Standard Model (home.cern/science/physics/standard-model).

The observer's ladder: organization in nature

New capacities arise when interacting processes form new organizations.



Networks of organisms, communities and environments.
Feedback connects agents across ecological scales.

Integrated living agents regulate interaction through sensing and action in relation to viability.

Autopoiesis: living systems continually produce and maintain themselves. Threshold of biological cognition.

Chemical organization transforms structures through reactions and exchanges of matter and energy.

Electromagnetic interaction, electron transfers and photon absorption or emission change atomic states.

Physical interactions change system states.
Minimal observation does not require consciousness.

Physical levels: minimal observer-agents register differences through changes of state and affect other systems.

Bidirectional links show enabling relations and feedback across levels of organization.

Biological populations and lineages evolve across generations.

Biological agency: organization driven by viability

Autopoiesis is the threshold for biological cognition:
a living system continually produces and maintains itself.

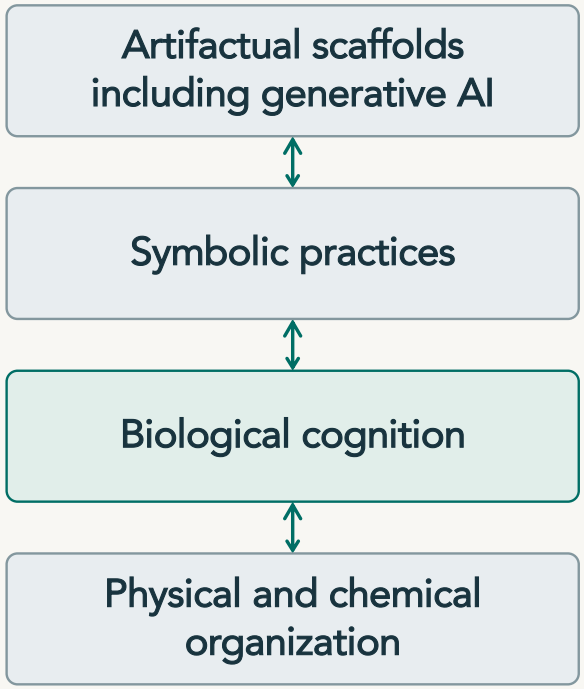
Causal interaction becomes significant relative to viability.
Biological agency regulates interaction in relation maintenance of living.

Within ICON, all living organisms are cognitive agents. (basal cognition)
Intelligence is flexible problem-solving capacity
and it can also be realized artificially.

Maturana & Varela (1980); Dodig-Crnkovic (2026)

The observer's ladder: cognitive extension

Biological grounding and artifactual extension of cognition in ICON



Externalized knowledge supports new possibilities for inquiry.
AI contributes to a coupled system whose goals remain human.

Language, writing, instruments and models externalize memory and supply materials and purposes for artificial intelligence.

Autopoiesis organizes interaction around viability.
Living agents develop capacities for sensing, action and learning.

Interacting physical systems provide the conditions for living self-production and self-maintenance.

Feedback: scaffolds reorganize the inquiry and action of living agents.

Cognitive activity can extend across a coupled system without every component becoming autopoietic.

Source: Dodig-Crnkovic, Relational Epistemology of Biological Agency with Artifactual Scaffold.

Generative AI as an artifactual scaffold

GenAI transforms externalized knowledge and changes
the possibilities available to a human inquirer.
(Andy Clark, GenAI as extended cognition)

Its proposals can redirect inquiry, including by exposing
an overlooked assumption. Its contribution is causally consequential.

The source of goals and the organization of interaction is decisive.
Problem-solving and fluency alone do not establish autonomous intent.

Clark (2025)

Levels of AI agency in scientific inquiry

Configuration	Organization of the contribution
Statistical software	Transforms data within a human-selected procedure
GenAI dialogue	Supports and expands and effectivizes inquiry
Hypothetical hybrid	AI retains project history and uses feedback for reciprocal adjustment across investigations

Across these cases, cognitive activity becomes distributed while the sources and goals of cognitive agency remain human.

The argument of the paper

What an observer-agent can know depends on its organization

The observer's ladder
New forms of organization enable new capacities to interact with the world.

Scientific knowing
Human agents, shared practices, instruments, models and institutions jointly shape what can be detected, interpreted and investigated.

GenAI as a scaffold
AI can contribute with its diverse intelligent functions to the scientific research. Here goals and aims as well as values are always defined by humans.

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