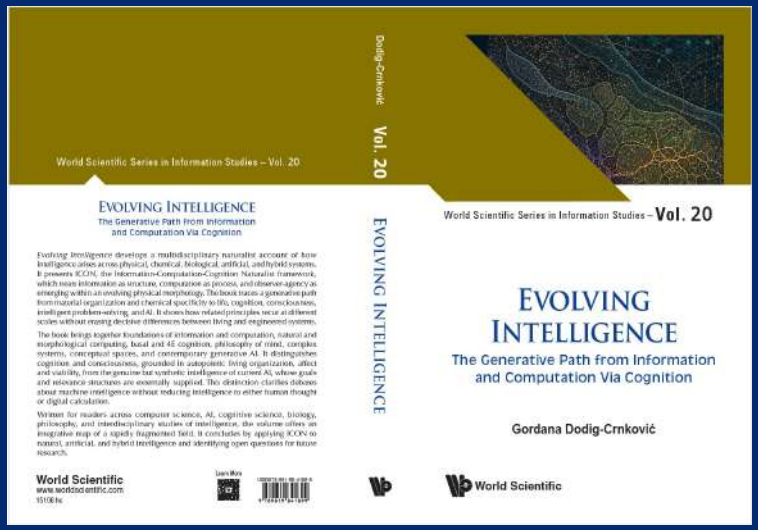
LUCS seminar · Lund · 20 October 2026

EVOLVING INTELLIGENCE

The Generative Path from Information and Computation via Cognition

World Scientific · Volume 20 · January 2027



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HOW DOES INTELLIGENCE ARISE IN NATURE?

Intelligence has a history of evolving organization.

Sensing, memory, and adaptive action have historical evolutionary roots reaching long before human reasoning.

Culture and technology extend the basis and expression of intelligence and possibilities for problem-solving in humans.

THE GENERATIVE ARGUMENT

Physical and chemical	Structures, interactions, and histories
Living	Self-production and viability-regulated cognition
Collective and symbolic	Coordination, language, and accumulated knowledge
Artificial and hybrid	Engineered and jointly organized problem-solving

MORPHOLOGY AND INTERACTION

Organization shapes what can happen next.

Morphology	Spatial and temporal organization
Interaction	Processes that transform organization
History	Persistent traces that affect later activity

OBSERVER-AGENCY ACROSS LEVELS

Level	Observer-agency in ICON
Physical	Interaction and the capacity to induce change
Biological	Action regulated relative to the system's viability
Artificial	Engineered action within externally supplied goals and conditions

In ICON, minimal observer-agency is a fundamental property of matter which is intrinsically active. Physical systems can initiate interactions through their own dynamics, as well as register and respond to interactions. Observer-agency is grounded in this activity of matter.

INFORMATION AND COMPUTATION

Information	Differences that make a difference (Bateson) for an observer-agent through interaction
Computation	Transformation of morphology that is informational structure for observer-agents. Information dynamics.

Umwelt: a book, different relations to observer-agents, different information

For a human reader: a source of meaning
For a paper-eating insect: food

PHYSICAL PRECURSORS OF HUMAN COGNITIVE CAPACITIES

Material traces	Memory. Previous interactions affect present responses
Chemical networks	Processes stabilize and reinforce one another
Living integration	Retained history contributes to ongoing viability regulation

THE TRANSITION FROM INANIMATE TO LIVING ORGANIZATION

Autopoiesis

Continuous production and regeneration
of the organization constituting the system

Viability

Conditions under which
that organization can continue

Valence

Conditions registered as favourable
or unfavourable relative to viability

COGNITION AS THE PROCESS OF LIVING

Within ICON, cognition is life at a given level of organization.

Embodied sensing connects the system to its environment.

Regulation relates activity to continued viability.

History guides how the system maintains and reorganizes itself.

INTELLIGENCE AS PROBLEM-SOLVING

Problems depend on a system's organization and circumstances.

A cell	Acquiring resources under changing conditions
A tissue	Coordinating repair and maintaining organization
An organism	Survival and goal directedness in a changing environment
A research community	Knowledge production: formulating, testing, and revising explanations

CONSCIOUSNESS IN ICON

Levels of embodied, valence-based self-sensing

Form	Organizational emphasis
Basal	Living self-sensing and viability (basal awareness and sentience, sense of “being alive”)
Multicellular	Integration of cellular “awareness” through cellular communication
Neural	Integration and structuring of multicellular information through nervous-system organization
Reflective	Explicit self-modeling and reflection in neural systems

Evidence for sensing and regulation is more direct than evidence for subjective experience.

COLLECTIVE ORGANIZATION AND COGNITIVE CAPACITIES

Coordination changes what a system can accomplish.

Cells and tissues	Local activity becomes coordinated within an organism
Organisms and groups	Communication supports shared activity on a larger spatio-temporal scale
Parts and wholes	Each level requires its own organizational explanation and subsumes previous levels

LANGUAGE, CULTURE, AND ACCUMULATED KNOWLEDGE IN HUMANS

Language	Makes bigger chunks of information/knowledge communicable
Records	Preserve knowledge across generations
Institutions	Organize transmission, criticism, and revision
Technology	Extends memory and problem-solving

ARTIFICIAL AND HYBRID INTELLIGENCE

Artificial intelligence	Engineered problem-solving in designed and trained architectures
Operational autonomy	Action without continuous step-by-step direction
Hybrid intelligence	Problem-solving organized through human–AI interaction

Open question: Could artificial systems develop self-production and intrinsic viability—and thereby lifelike cognition?

WHAT AN ICON EXPLANATION AIMS TO ESTABLISH

Which system and organizational level are being studied?

What interactions and transformations occur?

How does retained history affect subsequent activity?

What grounds the attribution of cognition or intelligence?

Which observations distinguish competing explanations?

EVOLVING INTELLIGENCE: OPEN QUESTIONS

Intelligence develops through changing forms of organization.

Which transitions warrant distinct cognitive categories?

How should we assess evidence for basal consciousness?

What would establish intrinsic viability in an artificial system?

World Scientific · January 2027 · doi.org/10.1142/15106

DISCUSSION: CORE DEFINITIONS

Concept	Working meaning in ICON
Morphology	Physical organization of nature, matter with its spatial and temporal structure. It appears as information for observer-agents at different scales.
Computation	Transformation (dynamics) of morphology/information
Cognition	Autopoietic, viability-regulated living activity
Intelligence	Problem-solving and goal-directed ability
Consciousness	Feeling of existence grounded in living self-sensing, emerging in degrees at different levels of organization

DISCUSSION: AGENCY AND BIOCHEMISTRY

Biological agency is physically realized through organized biochemical processes.

The explanatory question concerns agency, regulation, history, and viability.

In ICON, observer-agency is considered the most fundamental property of matter. In contrast to the picture of matter as merely inert, associated with Newtonian mechanics, ICON considers matter as ACTIVE, in the sense of its capacity to register inputs and act on them.

DISCUSSION: COMPUTATIONAL EXPLANATION

Description	Specify the informational states and transformations
Mechanism	Identify their physical realization and organization
Explanatory value	Show what the account predicts or helps us investigate

Mathematical representation and physical realization are distinct.
Computation in ICON is PHYSICAL, NATURAL COMPUTATION.
It is not Turing Machine Model which Turing himself called LCM *(LOGICAL computing machines)

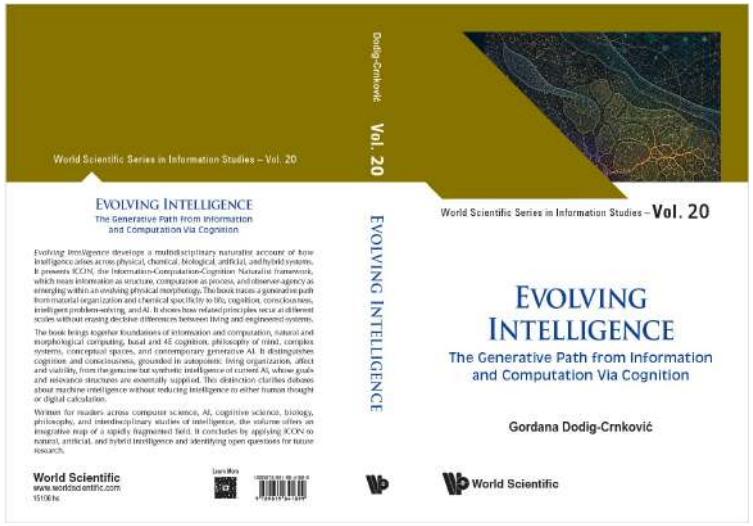
* On Computable Numbers, with an Application to the Entscheidungsproblem

DISCUSSION: POSSIBILITY OF AUTONOMY AND AUTOPOIESIS IN AI

Question	Relevant distinction
Can it act independently?	Operational autonomy concerns execution without stepwise direction
Does it produce its own organization?	Autopoiesis concerns continuous self-production and regeneration
What makes outcomes matter to it?	Intrinsic viability differs from externally supplied objectives
Is it conscious?	A further theoretical and evidential question

Neither task performance nor autonomy alone settles consciousness.

REFERENCES



Meet The Physicist Proving The Universe Builds Itself Out Of Information

Forthcoming book
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Video
Giant's Shoulder
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