

# Negentropy: Convergence of Evolution, Cognition, the Genetic Code and Origin of Life

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**Conflict of Interest Disclosure:** Author is founder of Natural Code LLC, which offers \$100,000 for discovery of a natural process that generates code from non-living material without direct human agency. Its investors offer \$10 million to secure patent rights to said process. The prize specification is at [www.naturalcode.org](http://www.naturalcode.org).



\$10 million prize announcement at the Royal Society with Denis Noble, FRS, CBE, Oxford University

**To the extent science can *prove*...**

# Erwin Schrödinger's "What is Life"

“Negative entropy” is the force that creates **order from disorder**. (Schrödinger 1944)



# Unsolved Problems in Biology

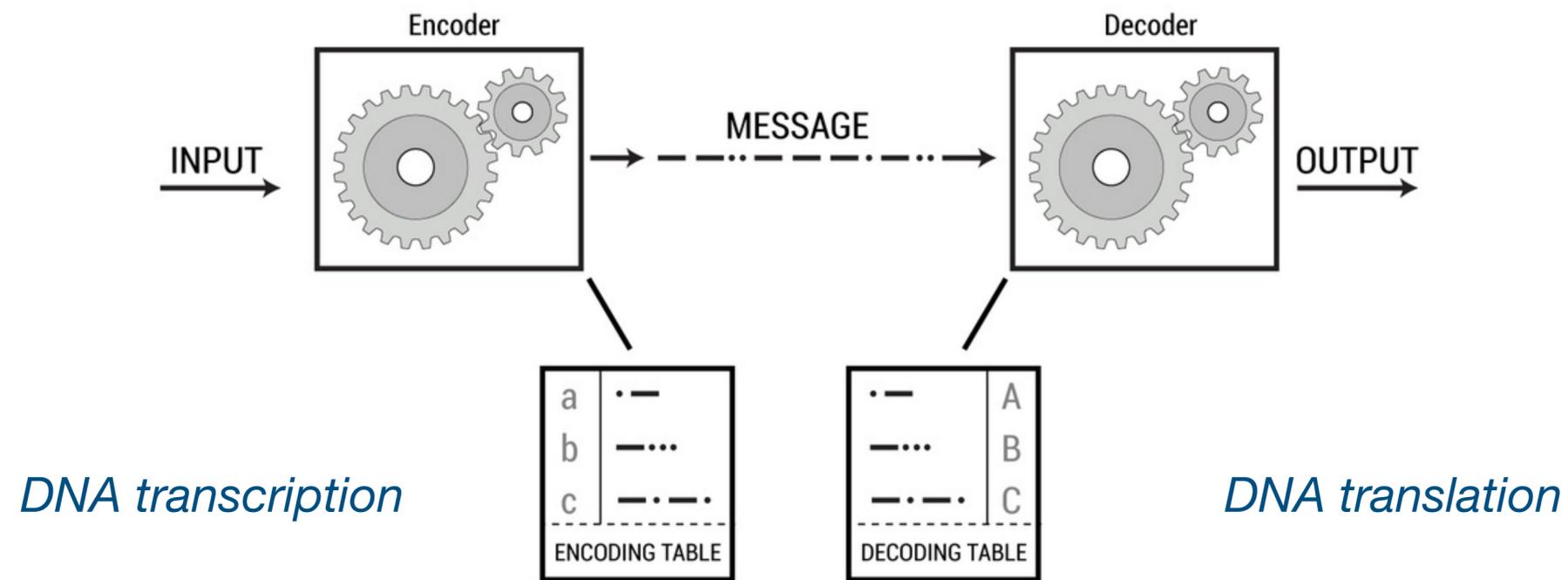
## 1. Negative Entropy

Negative information entropy is  
the **opposite** of noise

because it converts  
uncertainty → certainty,  
chaos → order

# Unsolved Problems in Biology

## 2. Origin of the Genetic Code



- *Chemicals don't control Information. Information controls chemicals.*
- *The rules of codes cannot be derived from the laws of physics (Yockey 2005)*

# Unsolved Problems in Biology

## 3. Evolution

- *Barbara McClintock damaged corn DNA. It re-arranged its genome immediately - without thousands or millions of failed trials (McClintock 1953, Shapiro 2022)*
- *John Torday, UCLA: Granddaughter inherits asthma via epigenetics from smoking grandmother (Torday & Rehan)*
- *Therefore organisms anticipate the future and evolve proactively*

# Unsolved Problems in Biology

## 4. Consciousness & Agency

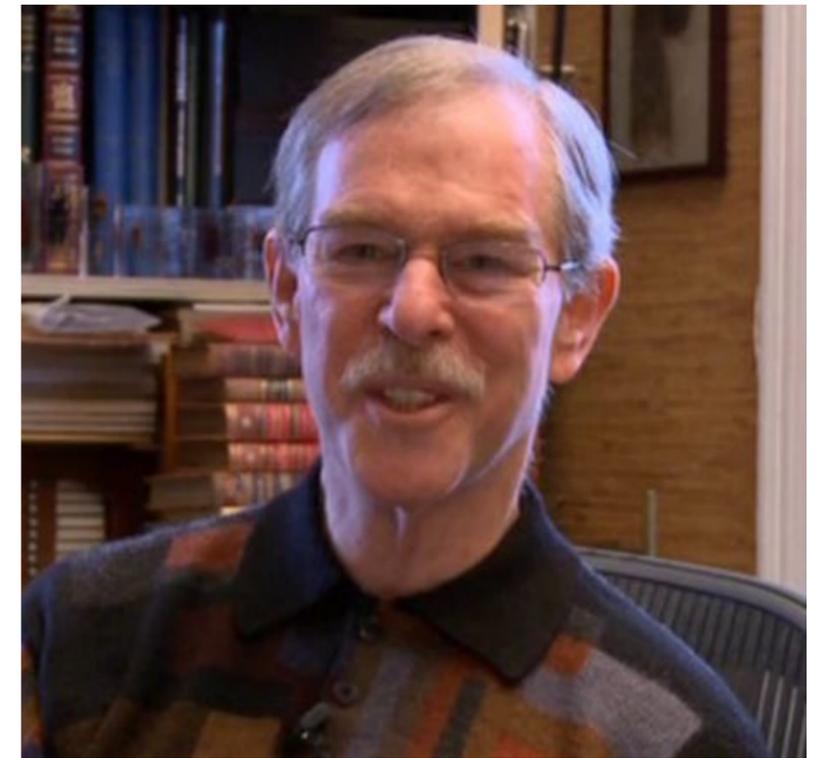
- *Sexual Selection = agency and choice (Darwin 1871, Noble & Noble 2017)*
- *All Living Cells are Cognitive\** (Shapiro 2020)

*\*Cognition Definition: “The mechanisms by which animals acquire, process, store, and act on information from the environment. These include perception, learning, memory, and decision making.” (Shuttleworth 2010)*

# Evolution is an Active Cognitive Process

- **Barbara McClintock: Cells actively restructure their own genomes** (McClintock 1953)
- **Epigenetics: Acquired characteristics passed to offspring** (Torday & Rehan, 2012)
- **Genome Chaos: Cancer cells massively re-arrange genomes** (Heng 2019)
- **High Speed Evolution: New species in weeks or months** (Marshall 2015)
- **Self/non-self identification in bacteria & cancer** (Ershova et al., 2015; Vasu and Nagaraja, 2013)

# All Living Cells are Cognitive (Shapiro 2021)



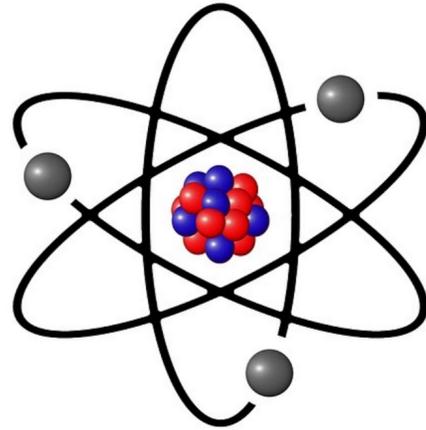
- Cognition refers to the total set of mechanisms and processes that underlie information acquisition, storage, processing, and use, at any level of organization (Baluška and Levin, 2016).
- Cognition manifests agency, which is exclusive to biology (Cronin and Walker, 2016)
- Neither physical laws nor random interactions make choices (Walker et al., 2017)
- What does a cell know about itself? (McClintock 1984)

# Unsolved Problems in Biology

## 5. All Artificial Intelligence is... *artificial*

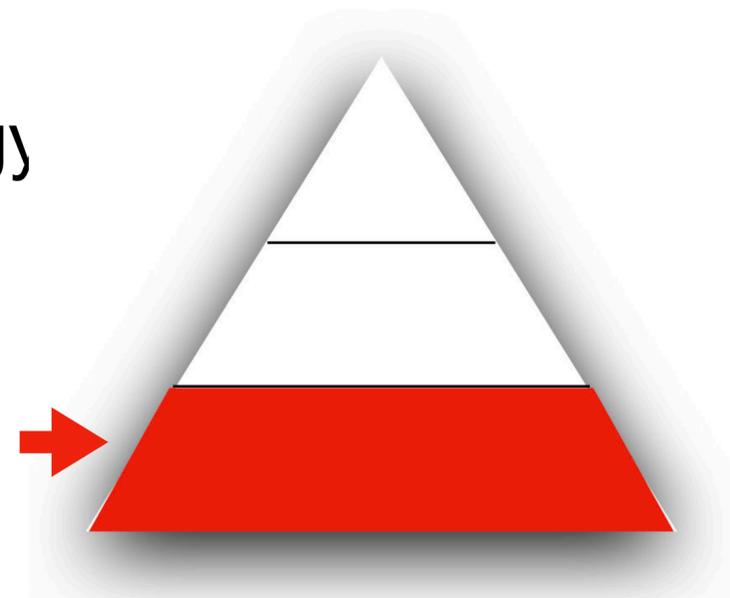
- *General Intelligence doesn't exist in machines (Ginsburg & Jablonka 2019)*
- *Animals have Universal Adaptive Learning. Computers don't. (Floridi 2018)*
- *Genetic Algorithms require goals from humans; not a major tool for software developers; do not rival biology (Skiena 2020)*
- *If we understood biology, computers could have agency*

# Three Levels of Causation:



## Bottom: Physico-Chemical (LAWS)

- **Universal** laws of physics and chemistry: matter, energy, light, heat, fields & waves, weather, stars, planets.
- Change over time is Order → Disorder (entropy)

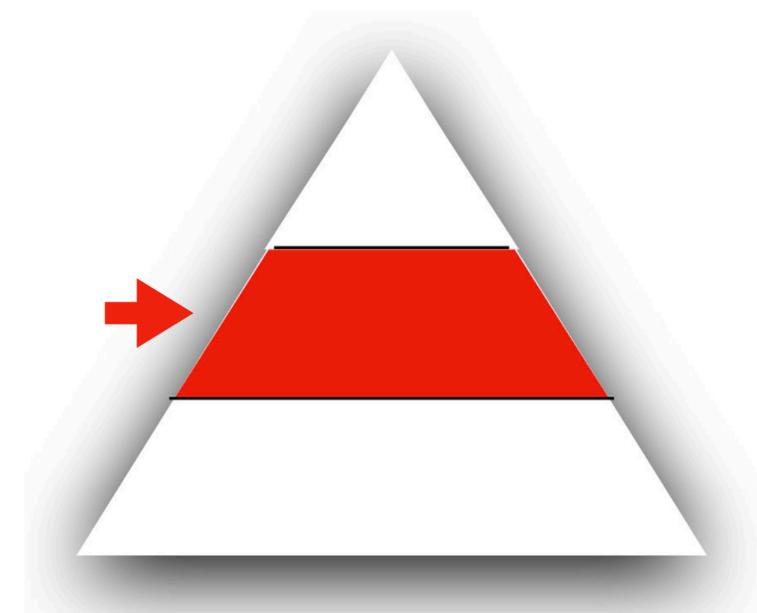


# Three Levels of Causation:

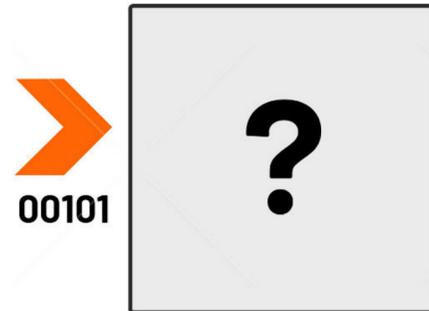
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## Middle: Code (LOGIC)

- Symbols, communication, computation, languages, machines, algorithms, genetics.
- Freely chosen **local** rules.
- Computation is deductive and deterministic: one output for given input.
- Codes are subject to noise (information entropy).

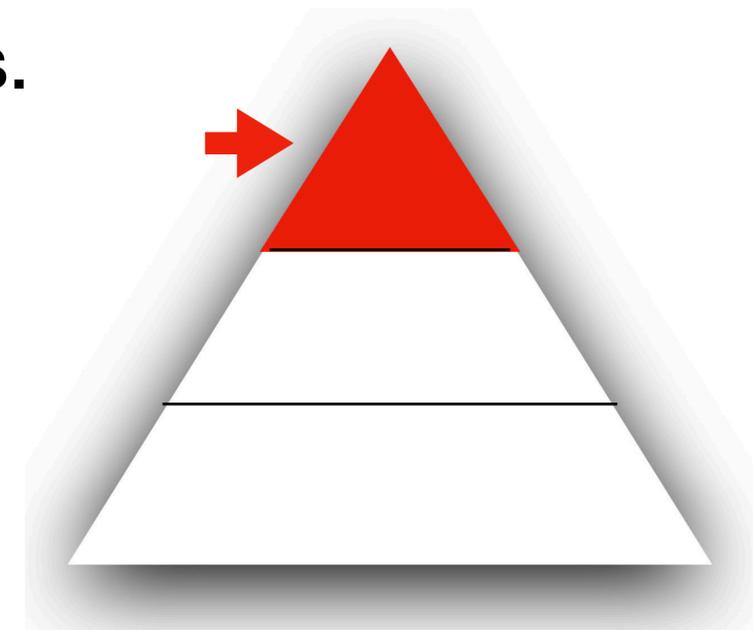


# Three Levels of Causation:



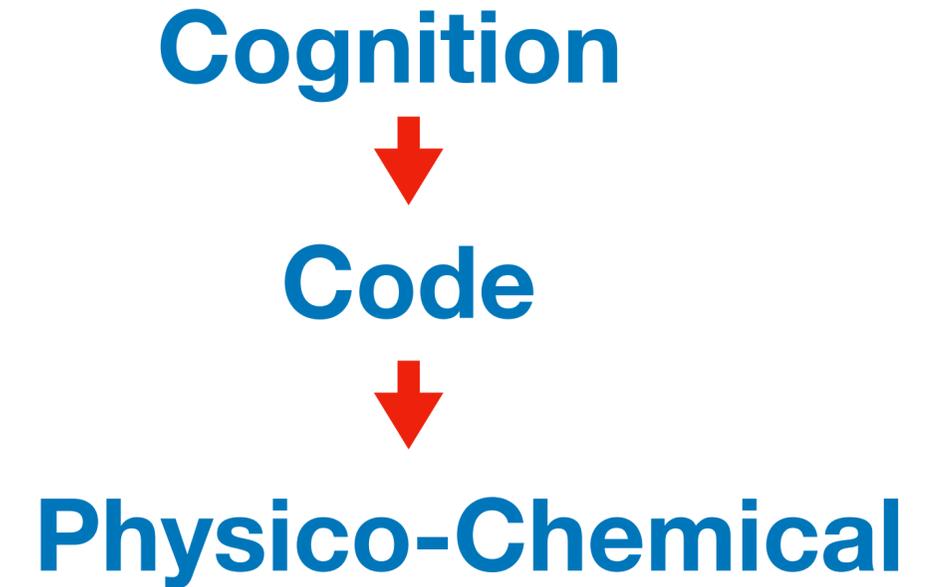
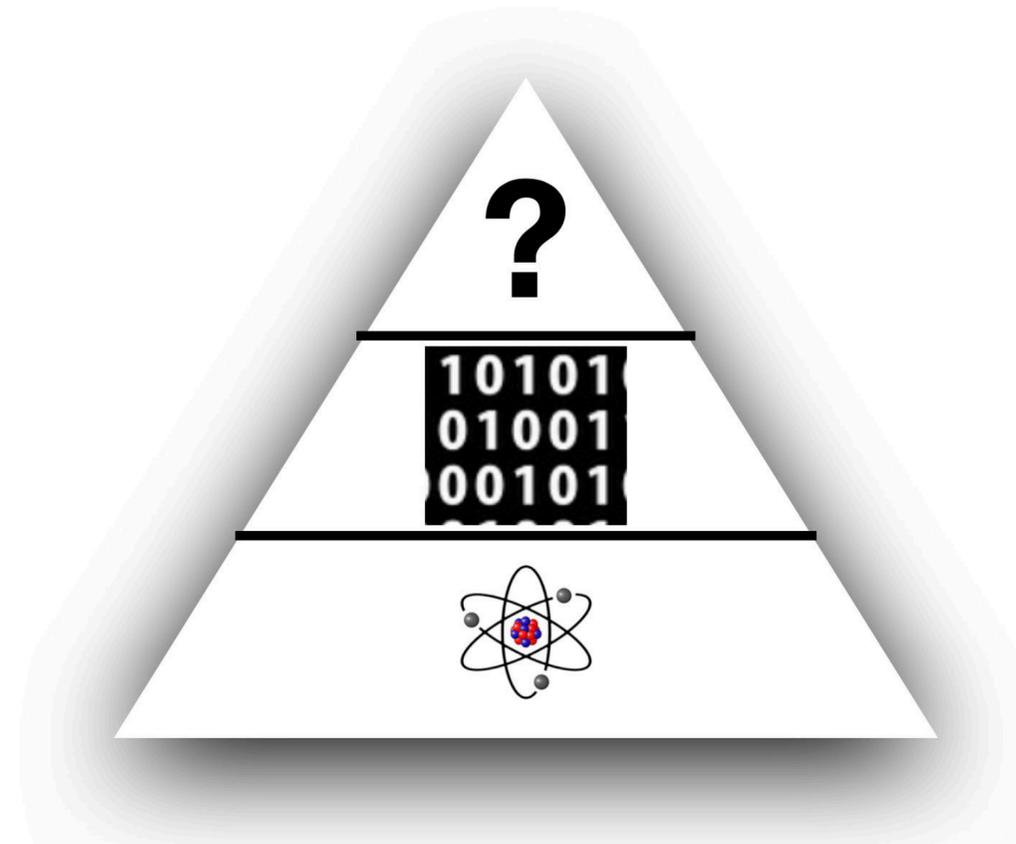
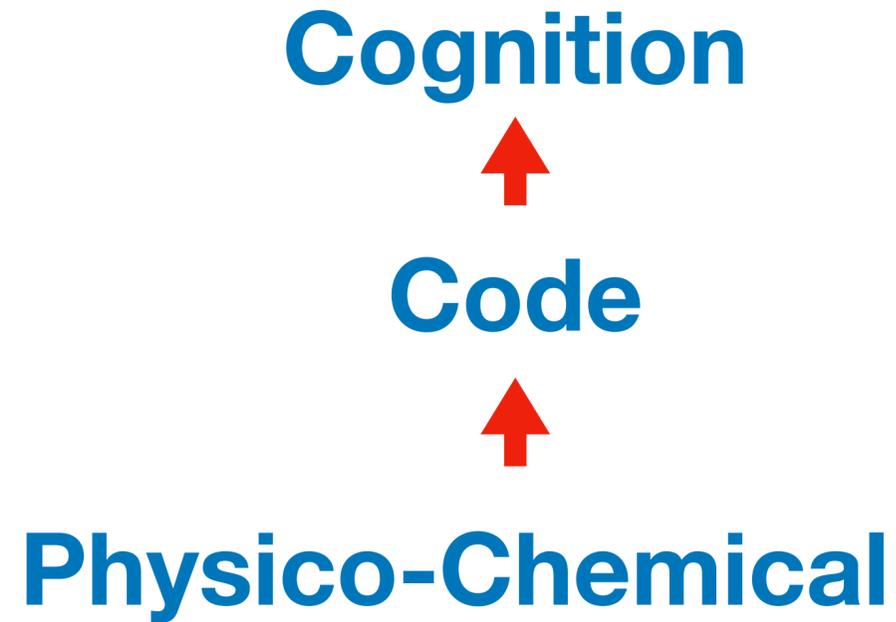
## Top: Cognition (CHOICE)

- Agency; action of self interest; meaning; creating codes.
- Cognition is inductive reasoning  
(choice within uncertainty) (Marshall 2021)
- Change over time is Disorder → Order (negentropy)  
(Schrödinger 1944).



# Convention:

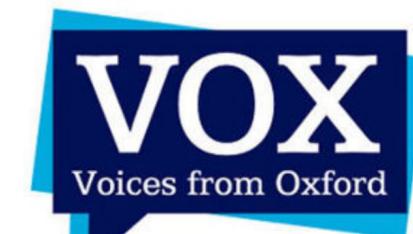
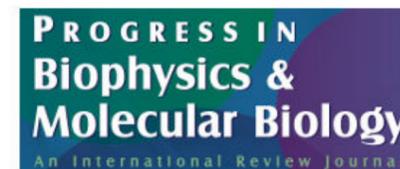
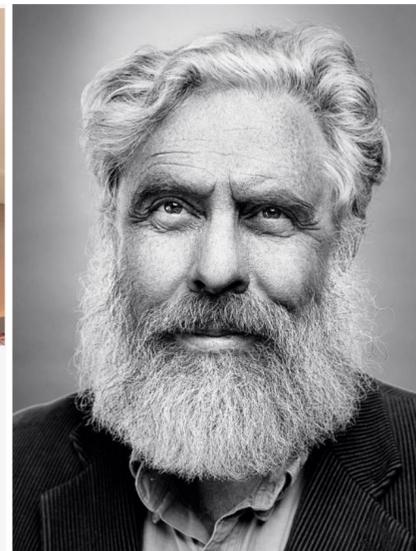
# Observation:



**No documented exceptions to date.** (Marshall 2021)



**Artificial Intelligence +  
Origin of Life Prize, \$10  
Million USD**



**We've gotten  
cause and effect  
backwards  
for 100 years**

# Equivalency of Choice Theorem

Applying **Turing Mathematics** and **Gödel Incompleteness**, the following are isomorphic\* in information theory:

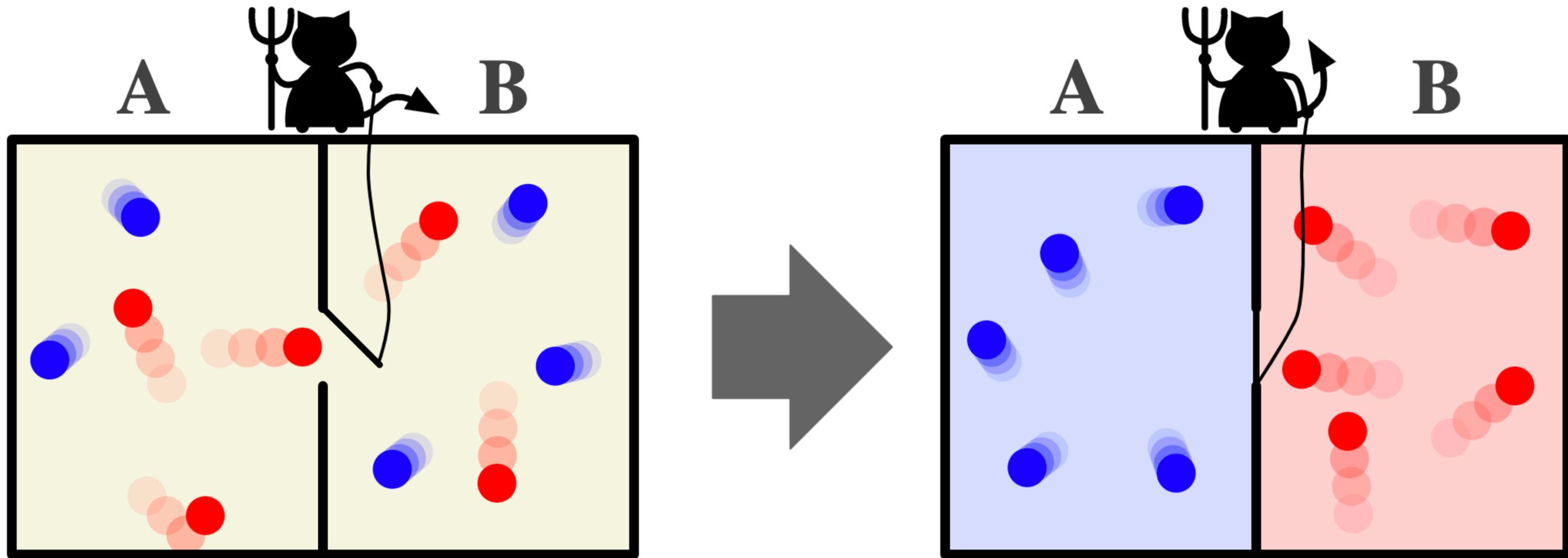
- Negative information entropy
- Assigning meaning to symbols
- Choices and Goals
- Evolution
- Axioms in mathematics
- Consensus on scientific laws
- Inductive Reasoning
- Turing's Halting Problem

**All are *undecidable propositions* which require goals.** (Marshall 2021)

**Life makes decisions that are impossible to compute**

\*corresponding or similar in form and relations

# Maxwell's Demon Must:



Choose whether *A* or *B* gets hot!

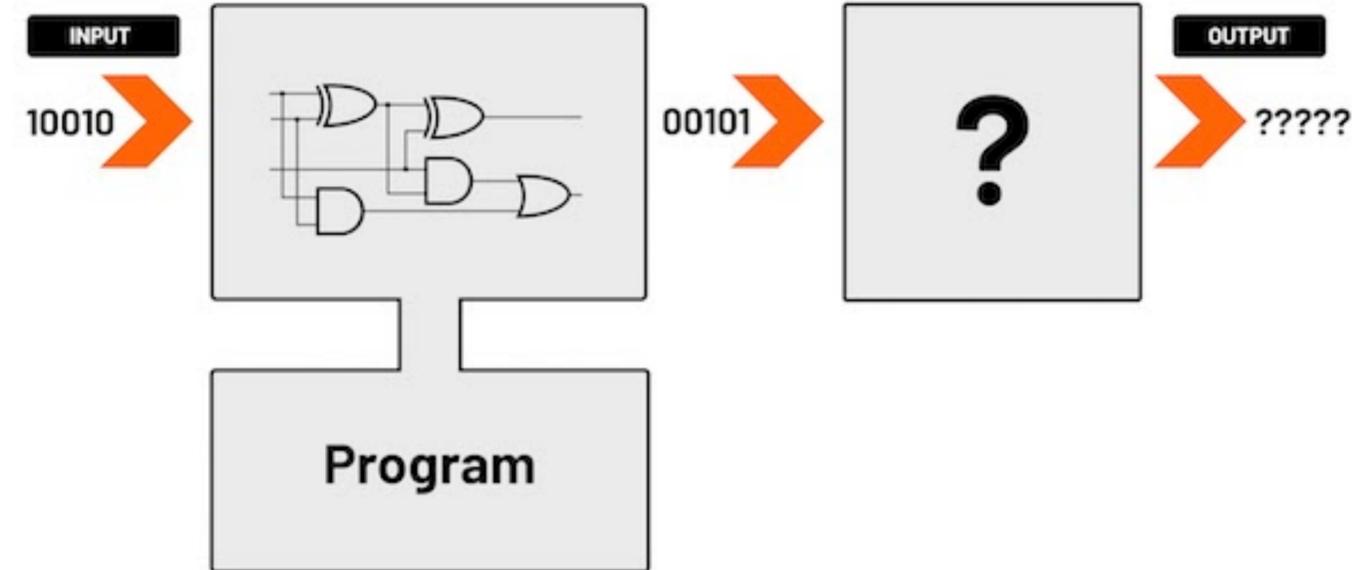
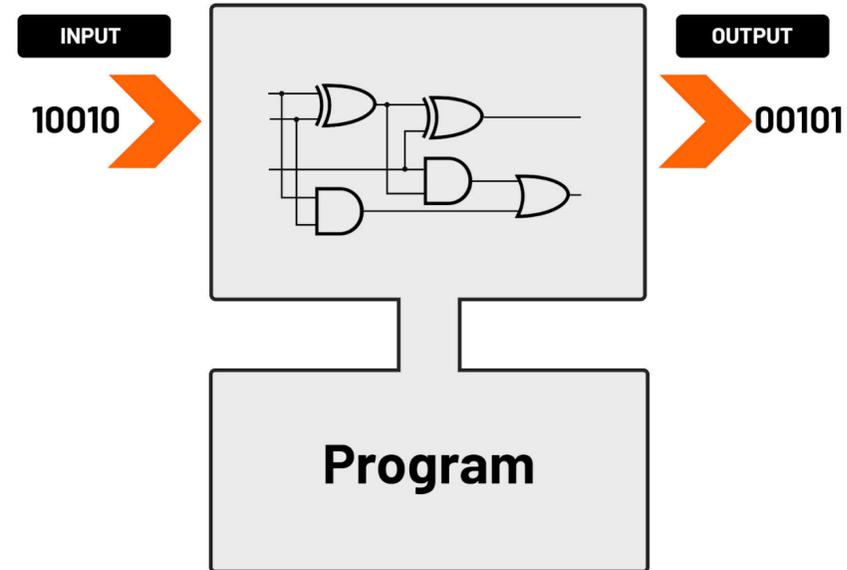
# Cognition Model

AI TODAY

WHAT AI ASPIRES TO BE

## TURING MACHINE

## VOLITIONAL TURING MACHINE



A computer only obeys  
its program

(DEDUCTION)

Chooses whether to obey the program or  
reverse the decision

(INDUCTION)

- Neither thermodynamic entropy nor information entropy have goals
- But Negentropy has **goals** and **direction**

(teleonomy / teleology / agency)

*Teleology: Multiple attempts at same goal despite unpredictable obstacles*

# Choices and Bits

Negative entropy is about **information, not energy!**

Negentropy is measured in bits, as is standard in communication.

**Coin toss = 1 bit of entropy**

**Choice** between two sides of a coin = 1 bit of **negentropy**



# Proof that Biology Transcends the Limits of Computation

## A. Math functions and computer programs are equivalent and deterministic

1. General recursive logic is by definition deductive and deterministic (“General recursive function - Encyclopedia of Mathematics”)
2. Turing machines (computers) are equivalent to general recursive logic (Turing 1936)
3. Therefore, computers are deductive and deterministic

## **B. Deterministic Turing machines are deductive**

1. Induction and deduction processes as defined above are mutually exclusive
2. Processes in classical Turing machines are equivalent to deductive processes
3. Therefore Turing machines cannot perform inductive reasoning

## **C. Adding randomness to Turing machines generates information entropy, not negentropy**

1. Turing machines become non-deterministic by adding randomness (noise) to a communication channel (Bohan Broderick, 2004; Hopcroft et al., 2001).
2. Randomness in a communication channel is positive information entropy (Shannon, 1948).
3. Therefore, non-deterministic Turing machines do not generate negative information entropy.

## **D. There is a severe limit on the size of useful statements that can be generated by randomness**

The statistical syllogism in support of the above statement is as follows:

1. For a computer to generate specific statements consisting of more than 332 bits of information (42 bytes, or 42 letters) through a random “brute force” process requires  $10^{100}$  trials to test all combinations
2.  $10^{100}$  trials could not be made by any real-world computer in the history of the universe.
3. Therefore, specific statements longer than 332 bits are not realizable through randomness.

## **E. Negentropy (choice) requires agency**

The statistical syllogism in support of the above statement is as follows:

1. Negentropy is choice
2. Only agents make choices
3. Therefore, negentropy requires (is equivalent to???) agency

The above is a statistical, not deductive proof, because there are **five possible solutions to the origin of the genetic code:**

I. Time travel is possible and humans designed the genetic code

I do not consider this to be possible.

II. Extraterrestrials designed the genetic code

Only kicks the can down the road.

III. The genetic code emerged randomly and accidentally

Not a testable hypothesis. Violates information entropy. Does not qualify as science.

IV. There are unknown laws or emergent properties of physics and chemistry

Merits further investigation, and is the subject of this paper: cognition and agency.

V. Divine intervention.

Possible but the I wish to avoid making god-of-gaps arguments (Marshall, 2015, Ch. 24), and furthermore implies that code precedes cognition, which I have already argued to be incorrect.

## **F. Generating mathematical axioms is, by definition, inductive reasoning, which requires choice**

The statistical syllogism in support of the above statement is as follows:

1. Computation requires axioms.
2. Axioms in mathematics are not computed but must be chosen inductively.

“Without inventing new constructive processes, no mathematician will get very far. It is perhaps proper to say that the strength of modern mathematics lies in the interaction between axiomatics and construction”  
(Hermann Weyl, 2013).

3. Therefore, computing is preceded by agency.

Given that biology is the only known source of agency in the universe (Cronin and Walker, 2016; Kauffman and Clayton, 2006) We conclude:

## **G. The agency [negentropy] exhibited by life is not matched by computers**

The statistical syllogism in support of the above statement is as follows:

1. Neither classical nor nondeterministic Turing machines can produce negentropy
2. Biology produces negentropy.
3. Therefore, **biological systems are not Turing machines, and biology transcends the limits of computation.** (Marshall 2021)

# **Statistical Proof, Not Deductive Proof (as Reliable as the principle of Entropy)**

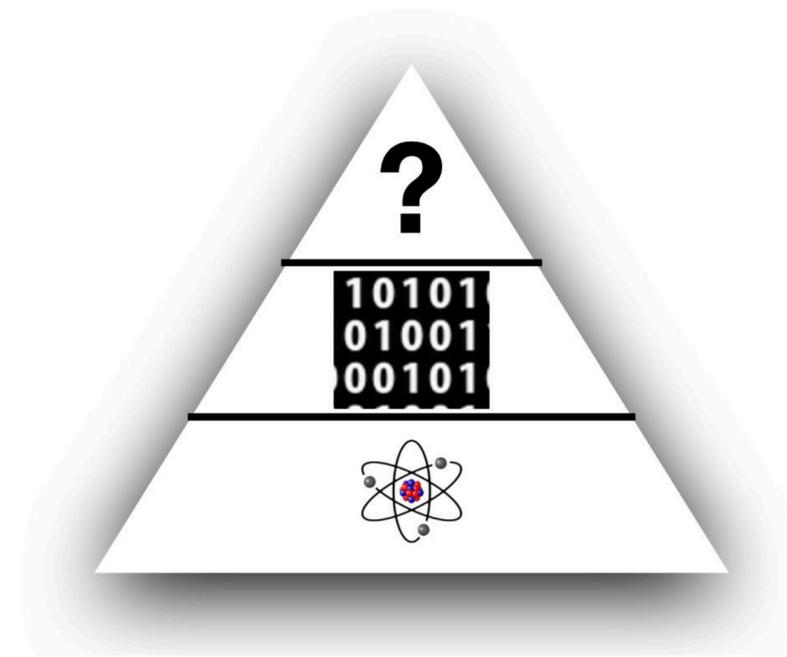
The proof is statistical and not deductive because entropy and negentropy are empirical and statistical entities, not pure mathematics.

In other words this proof is not absolute but is as inevitable as entropy. (Marshall 2021)

**Evolution is not random events. It is response to random events.**

**Evolution relies on principles of cognition that we do not yet understand.**

**Cognition**  
↓  
**Codes**  
↓  
**Chemicals**

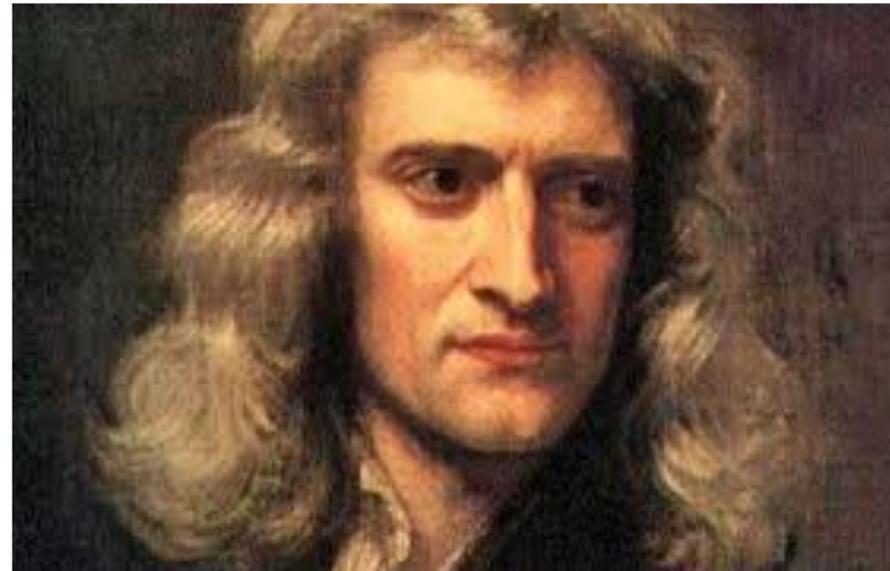


# How to Falsify the Cognition First Model

- Any experiment that demonstrates **chemicals → code** *with no assistance from biology*.
- Any experiment that demonstrates **code → cognition** *with no assistance from biology*.

# CONVERGENCE:

*What if...*



- **Negentropy**
- **Origin of Life**
- **Evolution**
- **AI**
- **Consciousness**

**...are not FIVE problems, but ONE?**

***What is the origin and nature of cognition?***

# Implications!

- Impossible to reduce biology to mathematics
- Reductionist methods will continue to fail in biology, origin of life, cancer
- Science itself is being redefined beyond fixed laws
- “Soft Sciences” are richer than “Hard Sciences”
- Missing “laws of physics.” Not like prior laws, but principles of agency

# Implications!

- Your goldfish is smarter than Alexa and Siri
- “AI” is all “A” and no “I”
- Sorry Ray Kurzweil... no “Strong AI” & no “Singularity” until this is solved
- **Quest for the next Nikola Tesla or Albert Einstein**



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