

Thermodynamics, Self-organisation and Life

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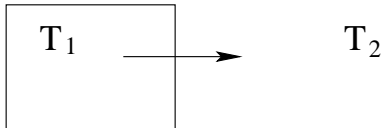
I. Conservation of Energy

$$dE = dQ + dW$$

II. Entropy of the Universe is increasing

$$dS \geq \frac{dQ}{T}$$

$$T_1 > T_2$$



$$dS = dS_1 + dS_2 \geq -\frac{dQ}{T_1} + \frac{dQ}{T_2}$$

Isolated systems always maintain constant total energy while tending toward maximum entropy.

$$\frac{dE}{dt} = 0$$

$$dS \geq 0$$

The emergence of order of any kind in an isolated system is not possible.

The probability that at ordinary temperatures a macroscopic number of molecules is assembled to give rise to the highly ordered structures and to the coordinated functions characterizing living organisms is vanishingly small. The idea of spontaneous genesis of life in its present form is therefore highly improbable, even on the scale of billions of years during which prebiotic evolution occurred.

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^a<http://www.ldolphin.org/mystery/>

Closed systems far from equilibrium

Energy flow through a system is the equivalent to doing work continuously on the system to maintain it some distance from equilibrium.

$$dS = dS_e + dS_i$$

dS_e = entropy flux due to energy flow through the system

dS_i = entropy production inside the system due to irreversible processes

The total entropy change in the system can be negative when

$$dS_e \leq 0 \quad \text{and} \quad |dS_e| > dS_i$$

Under such conditions a state that would normally be highly improbable under equilibrium conditions can be maintained indefinitely.

Open systems

In open systems, it is the flow of matter and energy through the system that allows the system to self-organize, and to exchange entropy with the environment.

In collecting and storing useful energy, plants serve the entire biological world.

If plants are deprived of sunlight or animals of food, dissipation within the system will surely bring death.

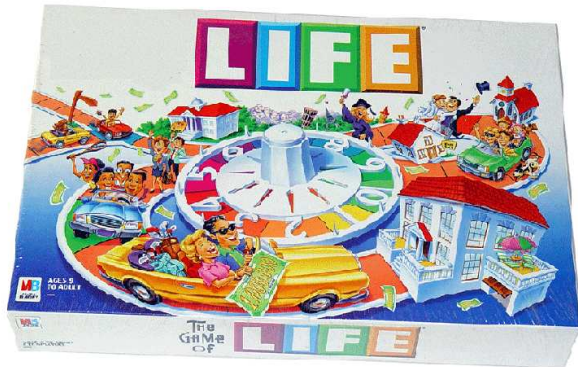


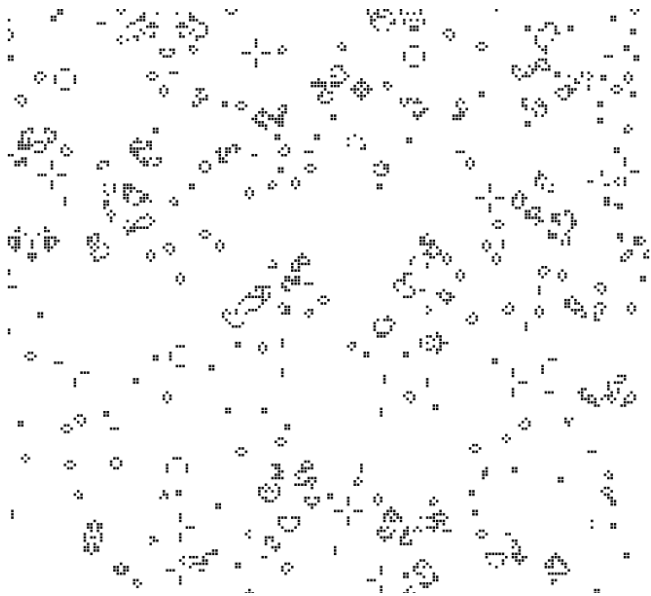
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¹<http://en.wikipedia.org/wiki/Emergence>

Flocking behavior







Emergence



... it has a layers.



Emergent self-organization appears frequently in cities where no planning or zoning entity predetermines the layout of the city.

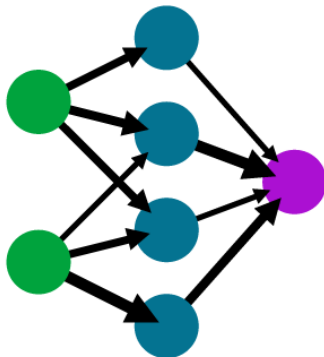


As a whole it precisely regulates the relative prices of companies across the world, yet it has no leader; there is no one entity which controls the workings of the entire market.



A simple neural network

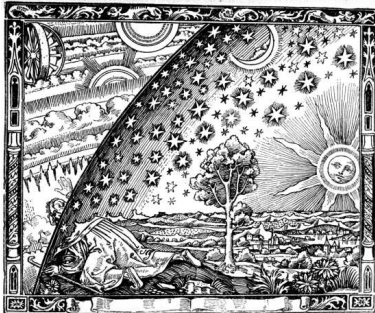
input layer hidden layer output layer



Holism vs. Reductionism

The whole is more than the sum of its parts.

Arsistotle



Un missionnaire du moyen âge raconte qu'il avait trouvé le point où le ciel et la Terre se touchent...

