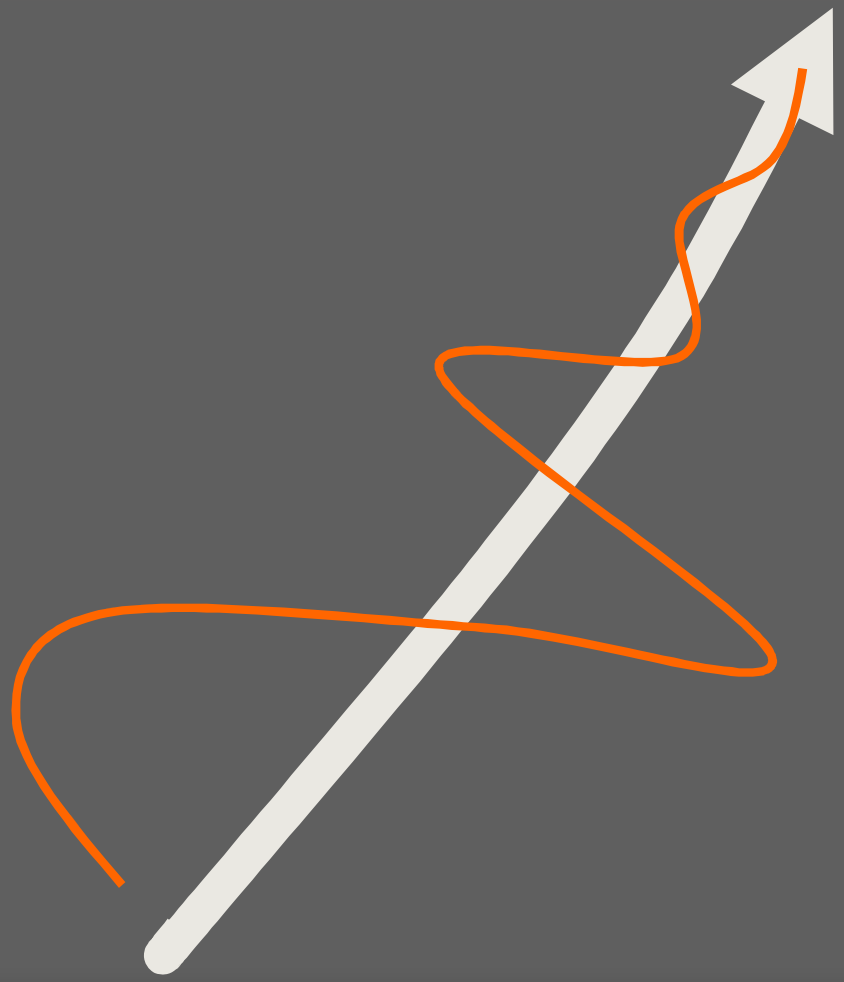
Tinklas, valdymas

Chaotinių sistemų valdymas



Teleonominės sistemos

- **Teleonomija yras struktūrų savybė veikti tariamai tikslingai**

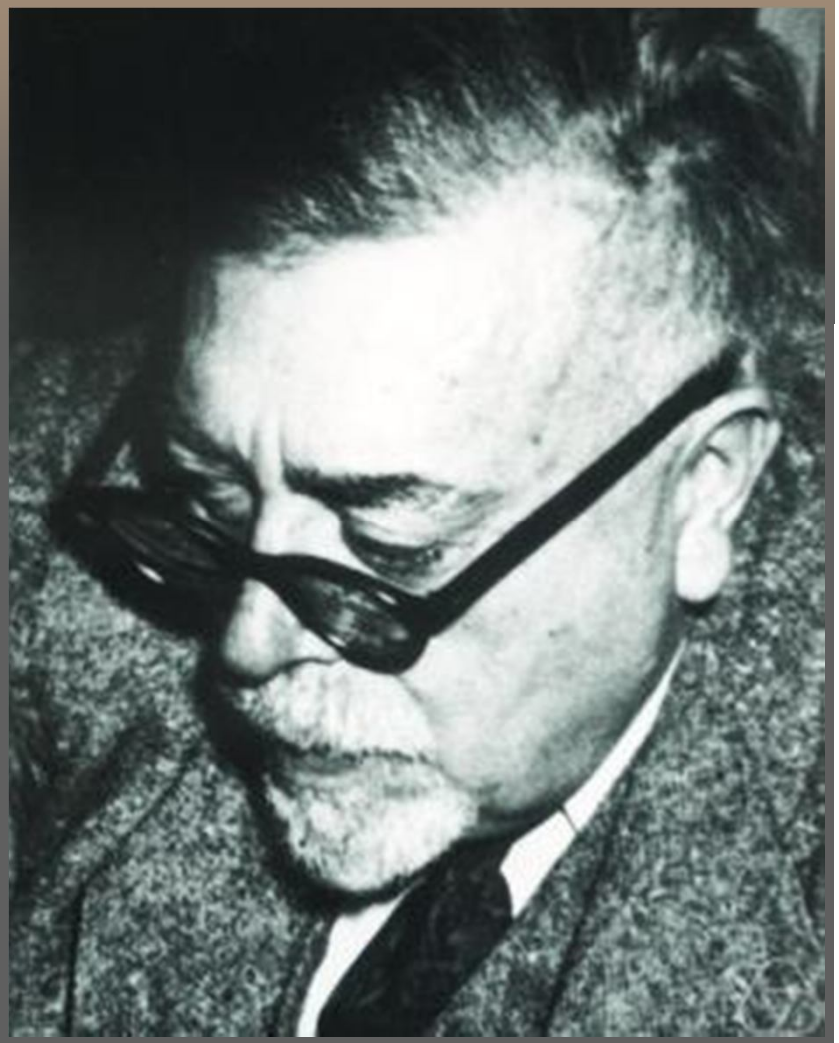
- Teleonominiai vyksmai, tokie kaip evoliucija, sukuria sudėtingus produktus. Informacija akumuliuojama apie funkcijas ir struktūras, kurios yra sėkmingos, taigi sudaromas grįžtamasis ryšys su aplinka, atrenkant pajėgesnes struktūrų koalicijas

Wikipedia

Kibernetika

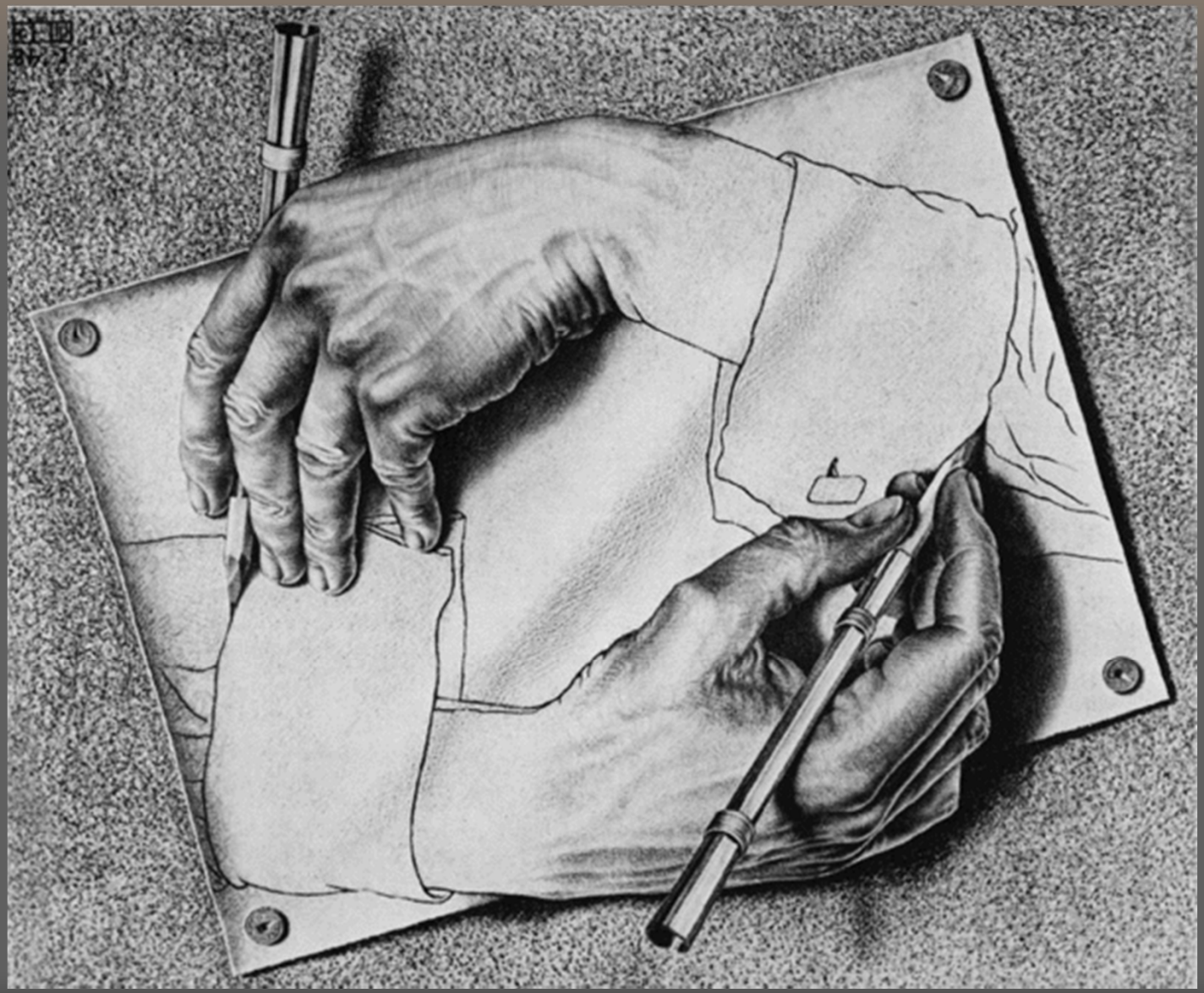
Kibernetika mokslas, tiriantis įvairių sistemų bendruosius valdymo procesus, kurie vyksta renkant, perduodant, laikant ir perdirbant informaciją.

1948, *Cybernetics: Or the Control and Communication in the Animal and the Machine.* Paris, France: Librairie Hermann & Cie, and Cambridge, MA: MIT Press.Cambridge, MA: MIT Press.



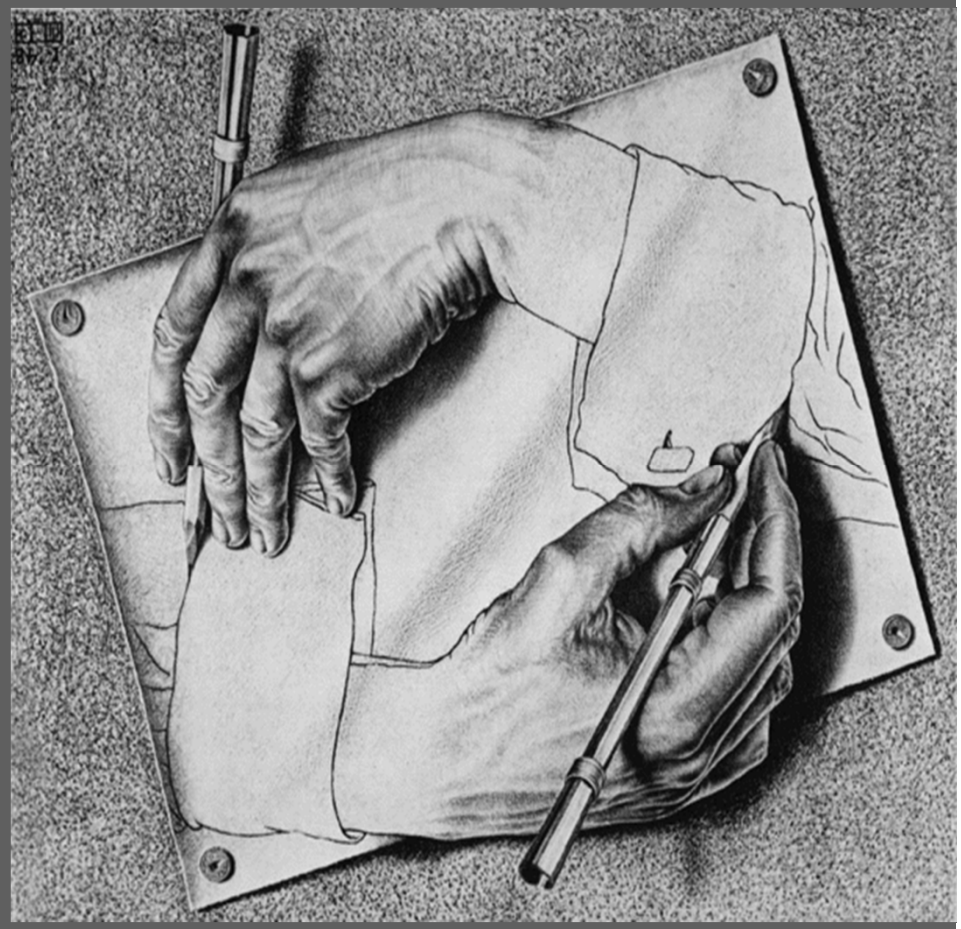
- **Norbert Wiener**
  1894 1964

Ciklai



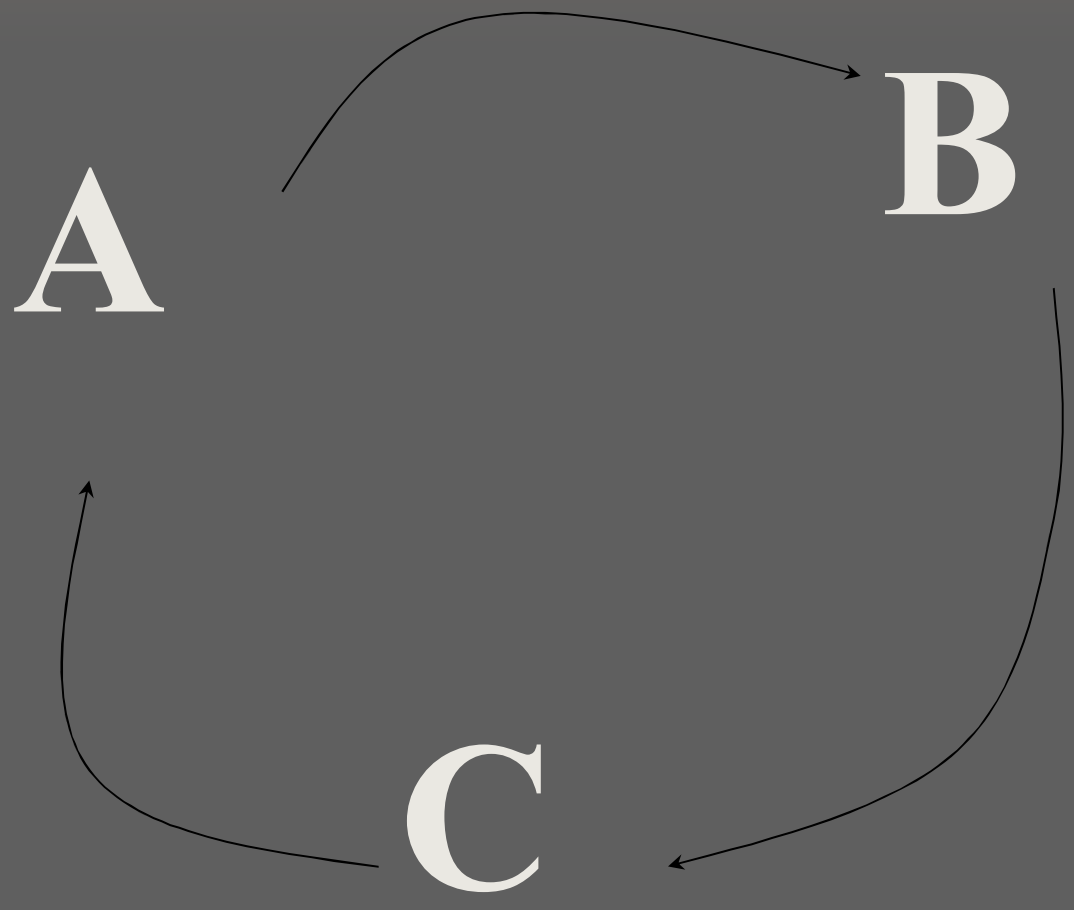
Kibernetinėms sistemoms būdingas “uždaras priežastinis ryšys"

Kibernetikai būdingos uždaros signalų kilpos, kuomet sistemos veikimas keičia aplinką, o jos tam tikri pokyčiai įtakoja pačią sistemą per informaciją, ar grįžtamąjį ryšį, kas priverčia sistemą pasikeisti, t.y. prisitaikyti prie naujų sąlygų. Taigi sistema tikslingai keičia savo elgseną.

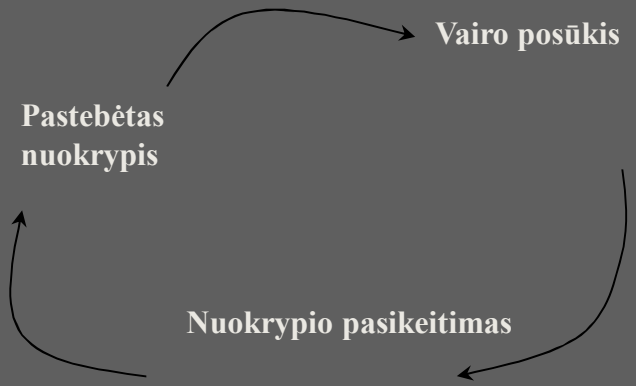


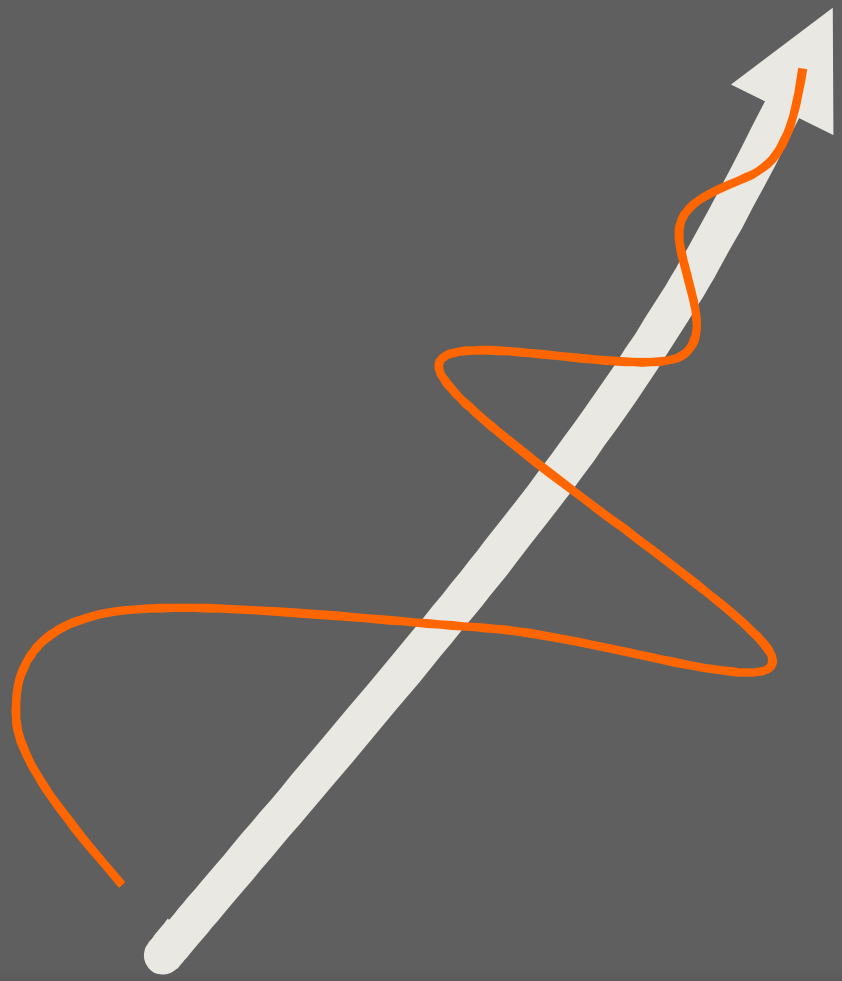
M.C. Ešeris “Piešiančios rankos"

Žiedinis priežastinis ryšys



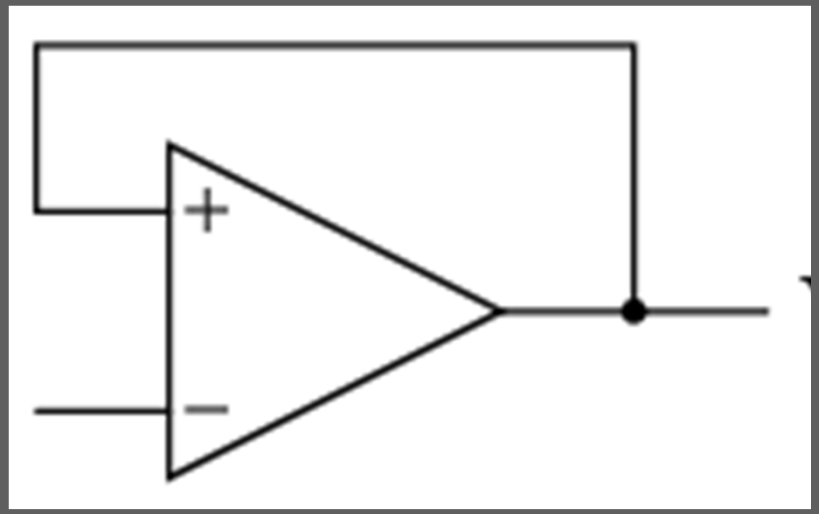
Valdymas grįžtamuoju ryšiu



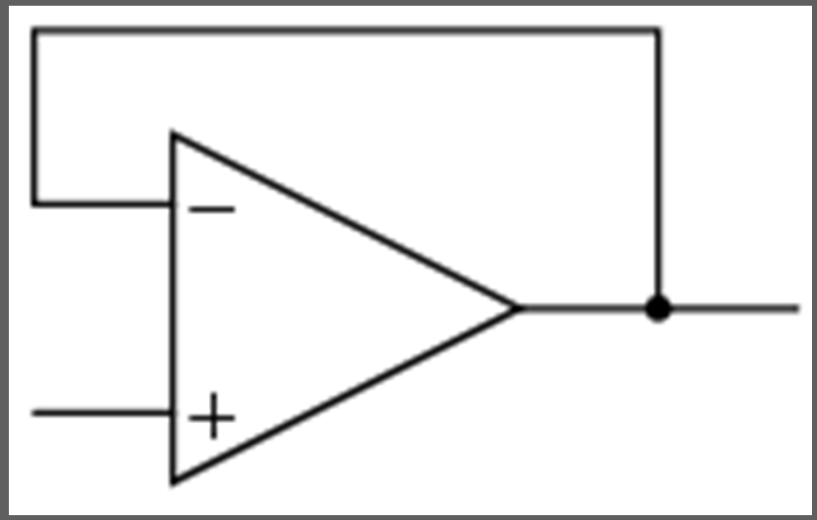


Chaotinių sistemų valdymas

teigiamas grįžtamasis ryšys

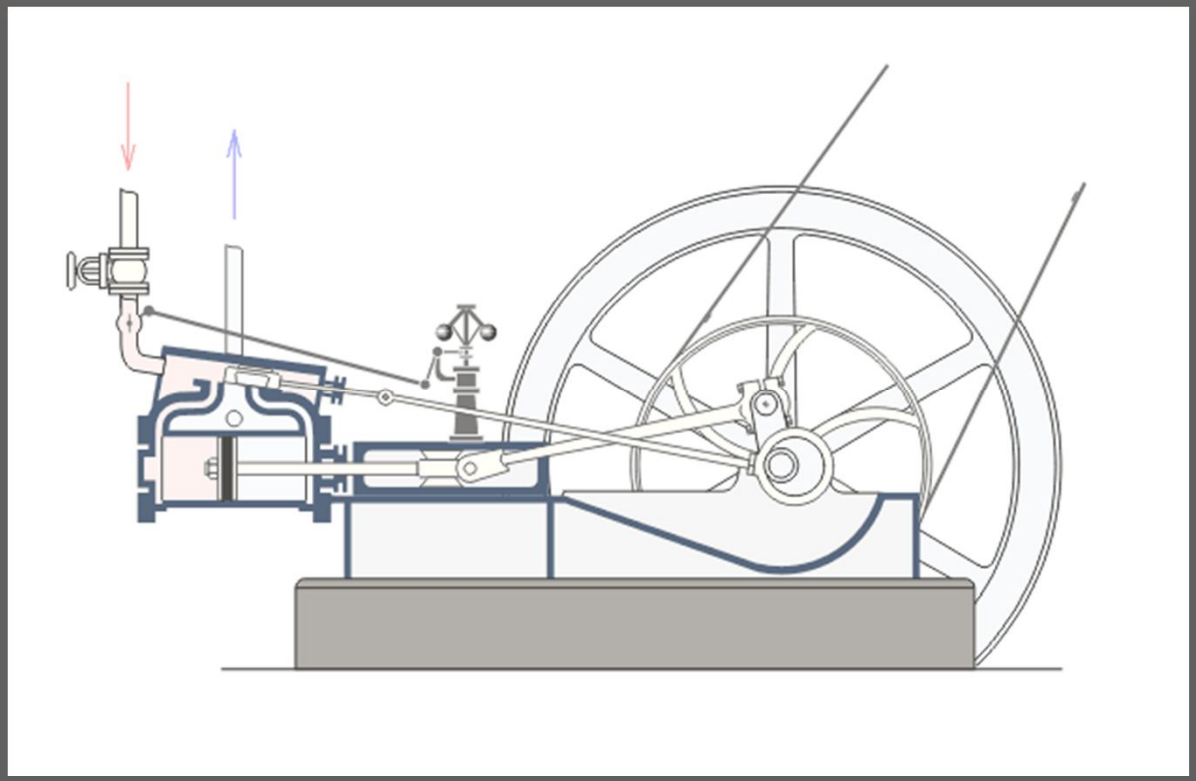


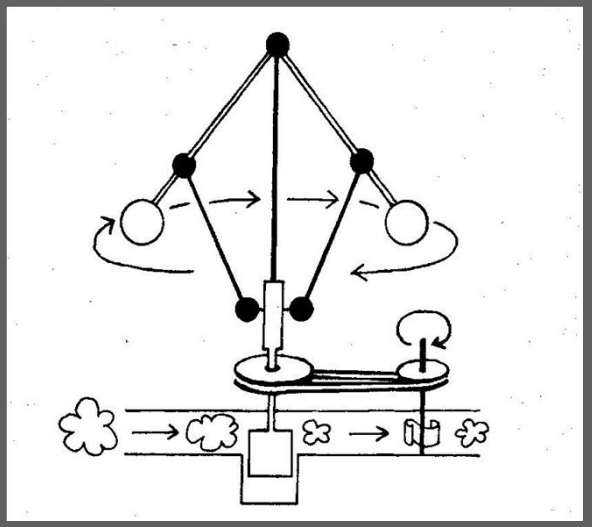
neigiamas grįžtamasis ryšys

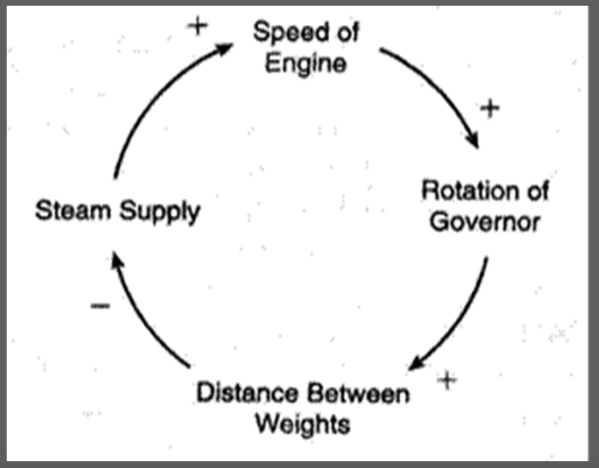


Teleonominės sistemos

J.Wato garo mašina



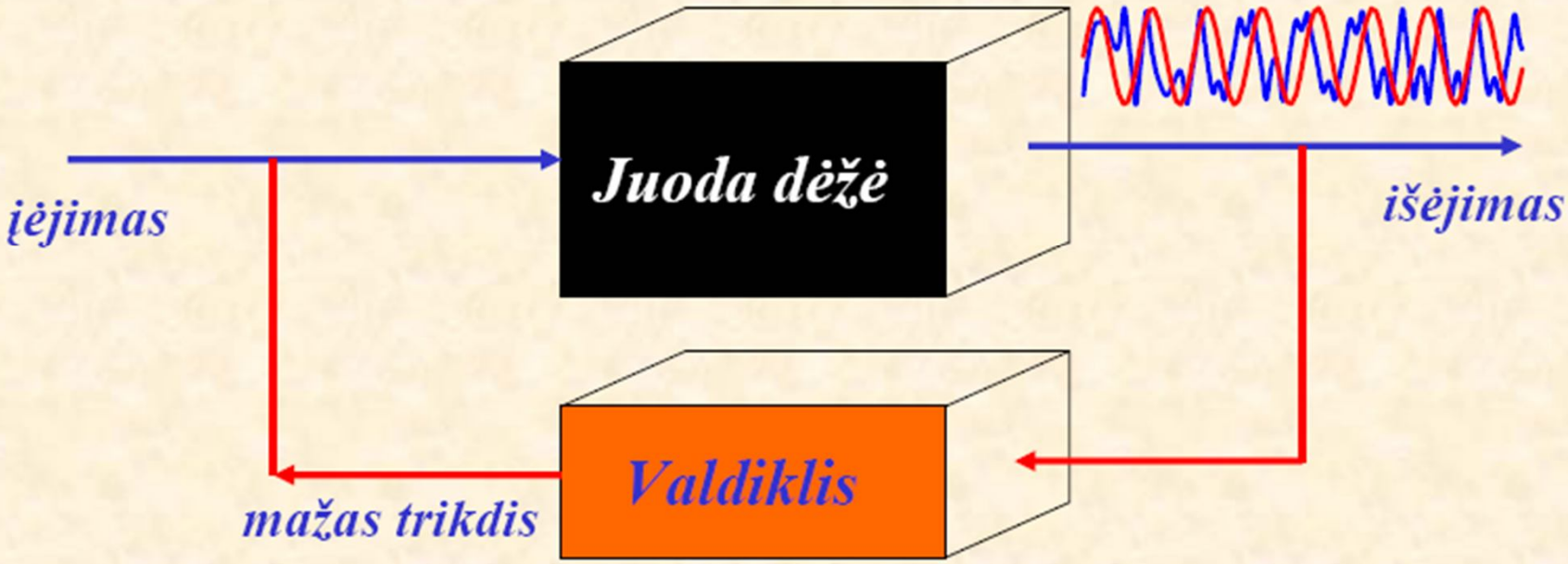




1781

Kontrolė grįžtamuoju ryšiu

Pagrindinės chaoso valdymo idėjos



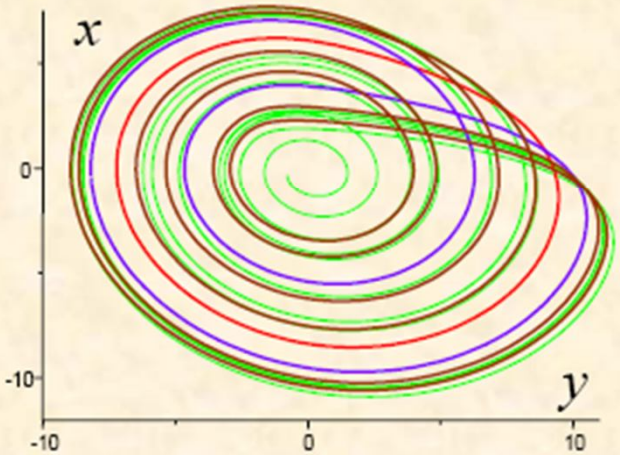
Chaoso valdymo idėja paremta dviem chotinių sistemų savybėm (Ott, Grebogy, Yorke, 1990):

- **nepaprastu jautrumu mažiems trikdžiams (drugelio efektas)**
- **keistasis atraktorius yra sudarytas iš begalinės nestabiliųjų periodinių orbitų aibės. Bet kurią iš jų galima stabilizuoti mažu trikdžiu.**

Pagal K.Pyragą

Nestabiliosios periodinės orbitos (Rioslerio atraktorius)

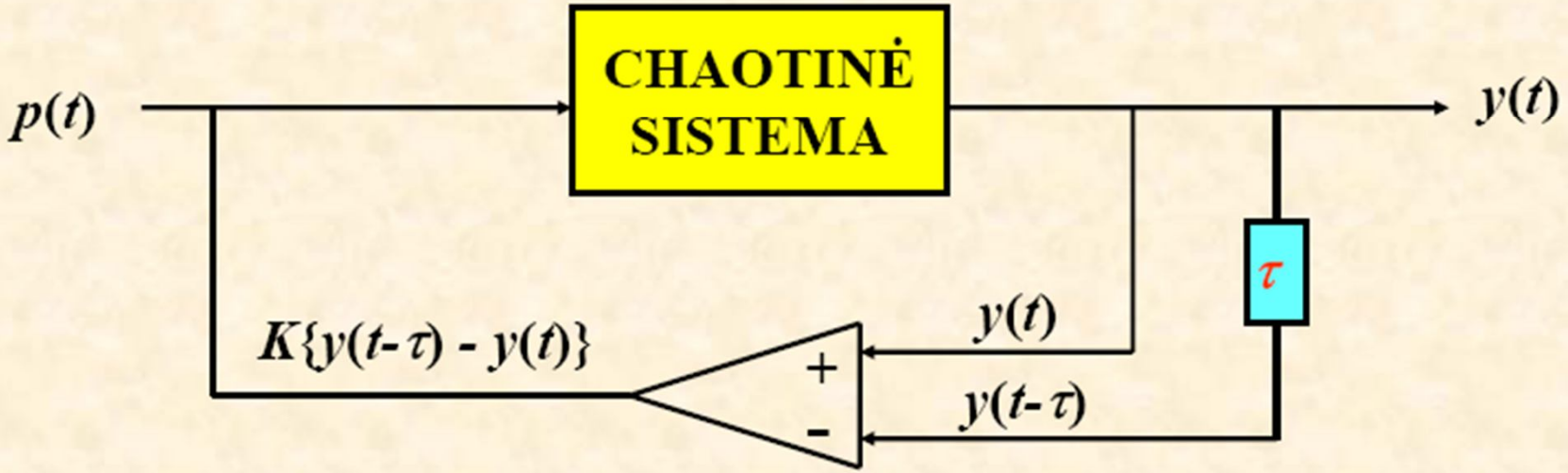
$$\dot{x} = -y - z$$
$$\dot{y} = x + a\,y$$
$$\dot{z} = b + z(x - c)$$



Pagal K.Pyragą

Uždelsto grįžtamo ryšio valdymo (UGRV) metodas

K. Pyragas, Phys. Lett. A 170, 421 (1992)



$$\dot{\vec{x}} = \vec{f}(\vec{x}, p)$$
$$y(t) = g(\vec{x})$$

$$p = p(t) = K[y(t) - y(t-\tau)]$$

τ – nestabilios periodinės orbitos periodas

- *Pagal ISI duomenis šis straipsnis pacituotas per 950 kartų.*

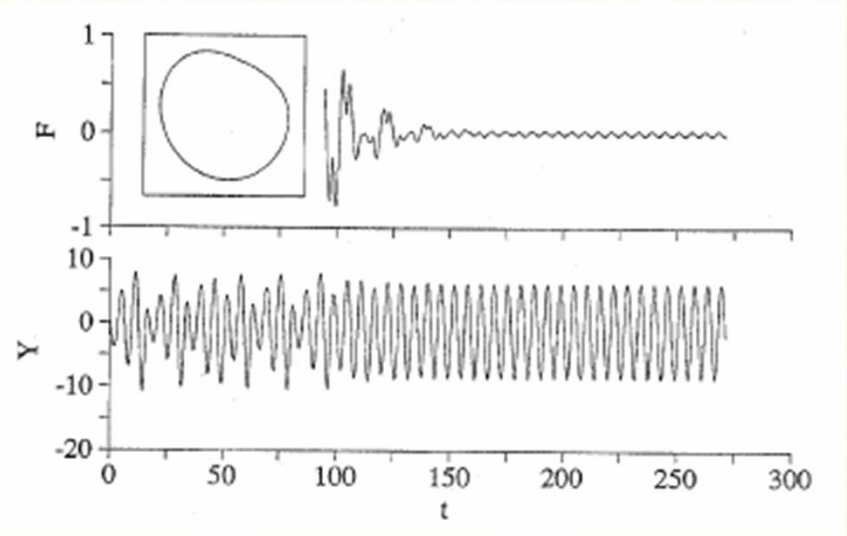
Pagal K.Pyragą

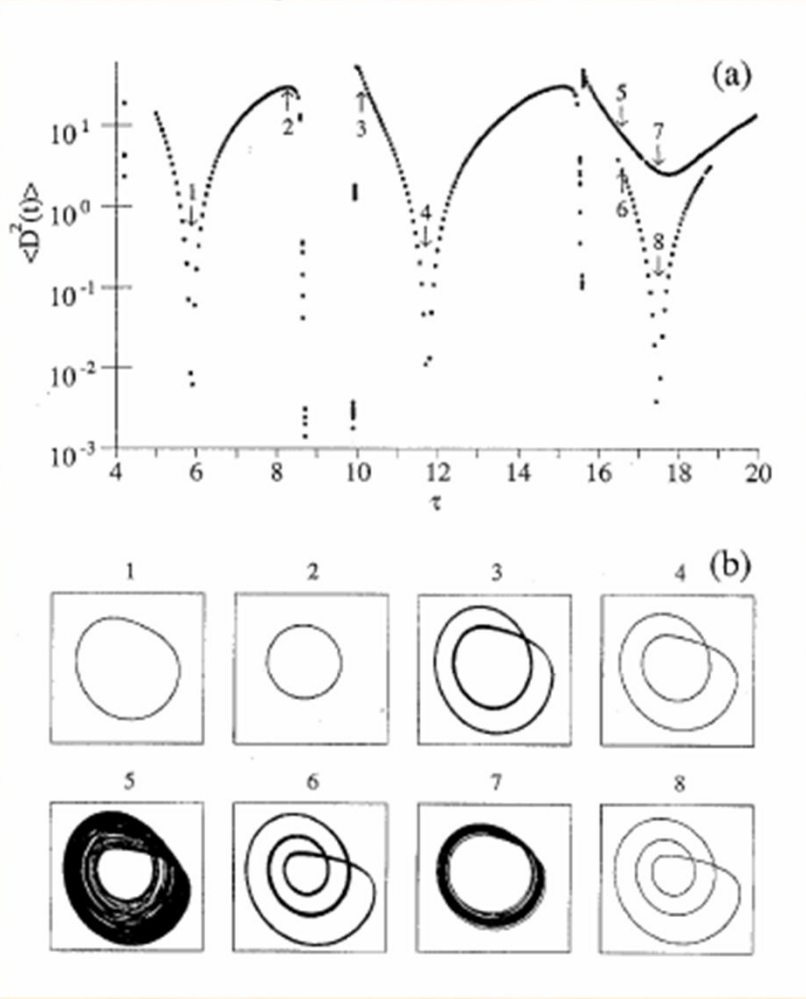
UGRV metodo iliustracija (Rioslerio sistema)

$$\dot{x} = -y - z$$

$$\dot{y} = x + a\,y \; + K\{y(t-\tau) - y(t)\}$$

$$\dot{z} = b + z(x - c)$$

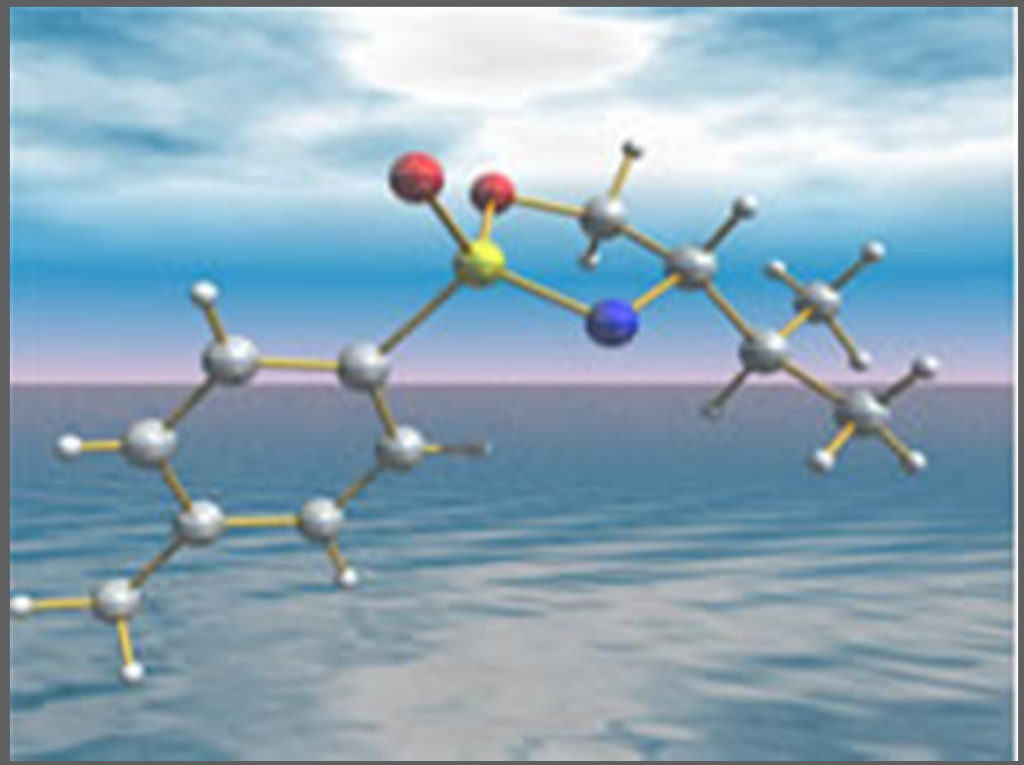




Pagal K.Pyragą

Biochemija

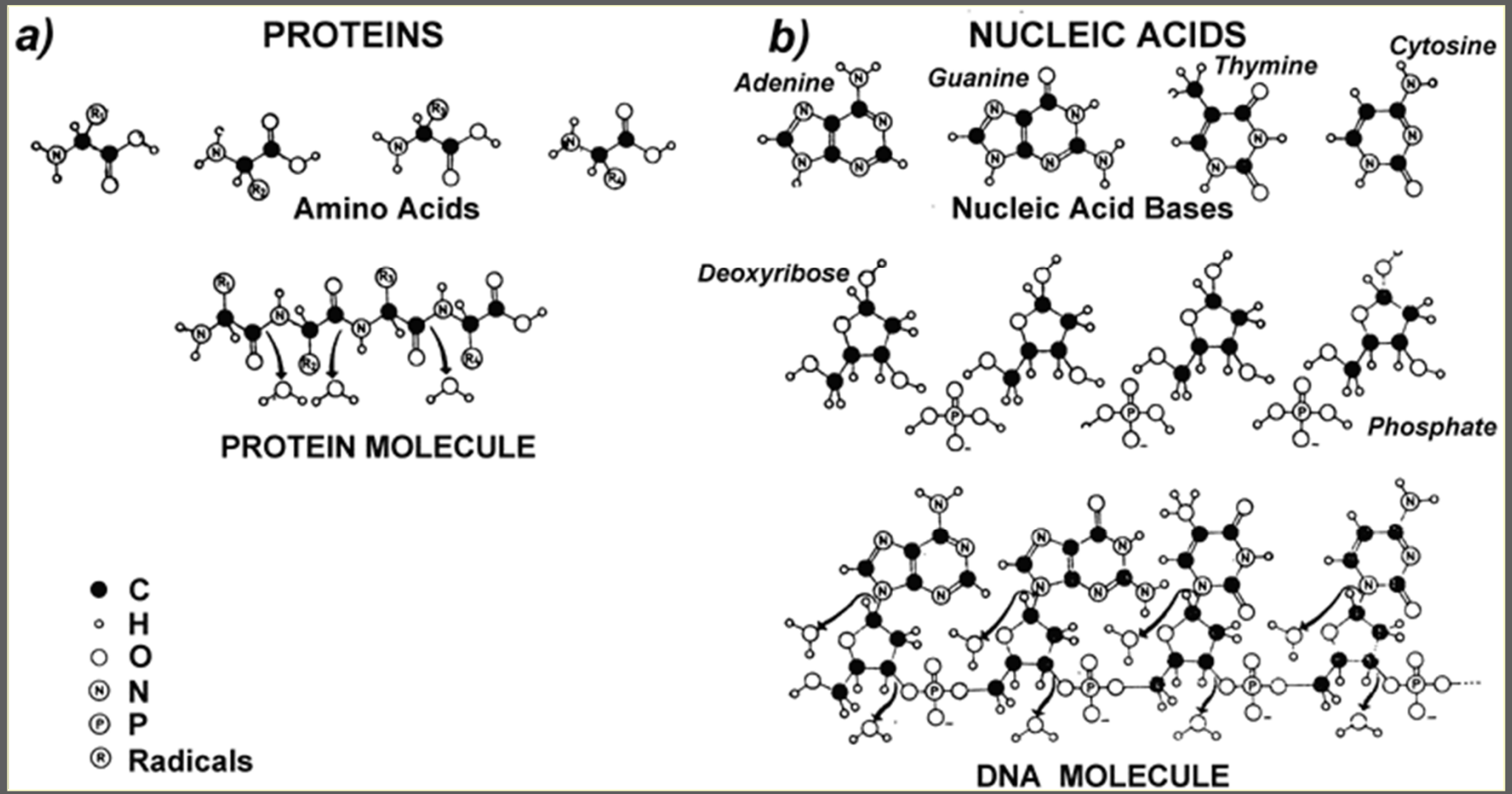
- Katalitinės reakcijos



Gyvybės polimerai

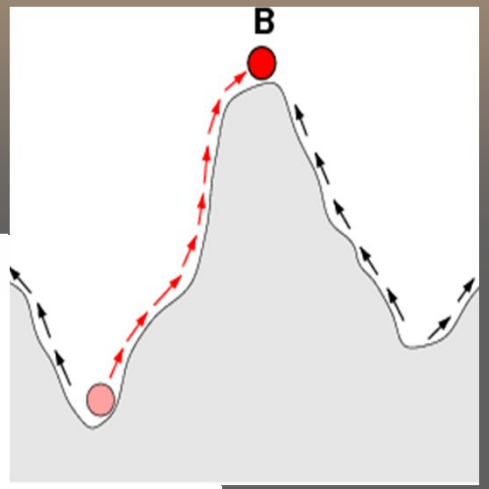
baltymai ir nukleidinės rūgštys

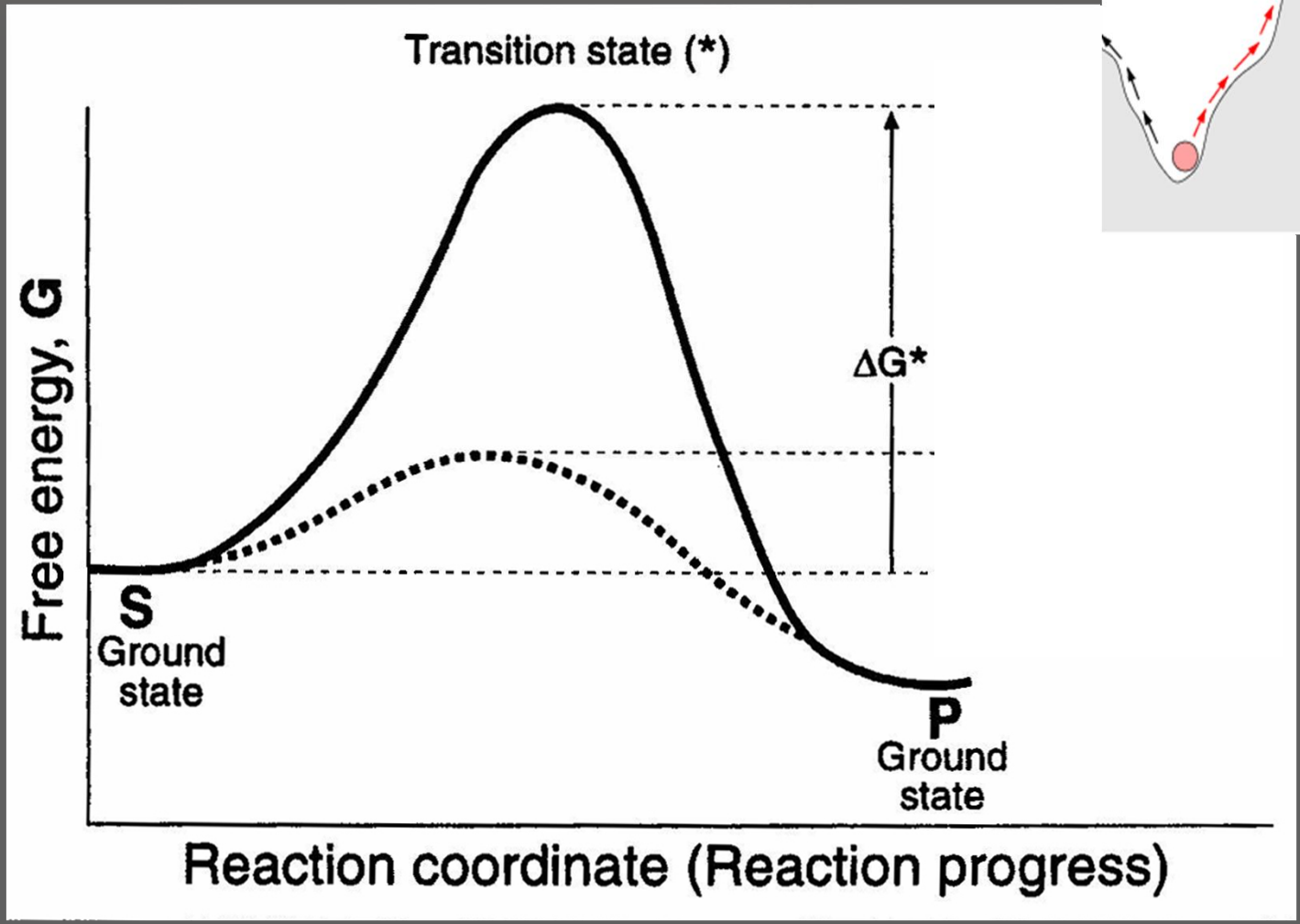
a - formation of protein macro-molecules from amino acids; living organisms contain 20 so called universal amino acids
b - formation of the macro-molecule of desoxyribonucleic acid (DNA) from nucleic acid bases, desoxyribose and phosphate. The sequence of four nucleic acid bases - adenine (A), guanine (G), thymine (T), and cytosine (C) in a DNA molecule codes genetically the sequence of amino acids in protein molecules; each DNA base triplet (e.g. AGC) codes a definite amino acid



Cheminės reakcijos

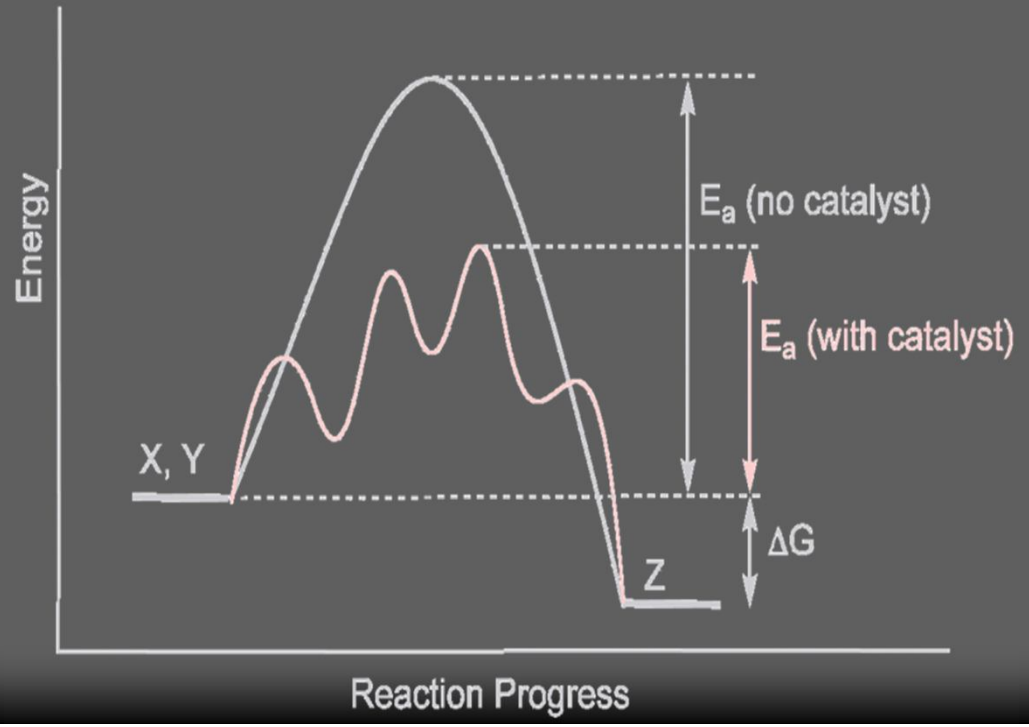
Aktyvacijos energija





Katalizė

- **Katalizė** yra procesas, kuriame cheminės reakcijos sparta stipriai sumažinama arba padidinama kitos cheminės substancijos, vadinamos **katalizatoriumi**. Skirtingai nuo kitų reagentų, dalyvaujančių reakcijoje, katalizatorius nėra pats naudojamas.

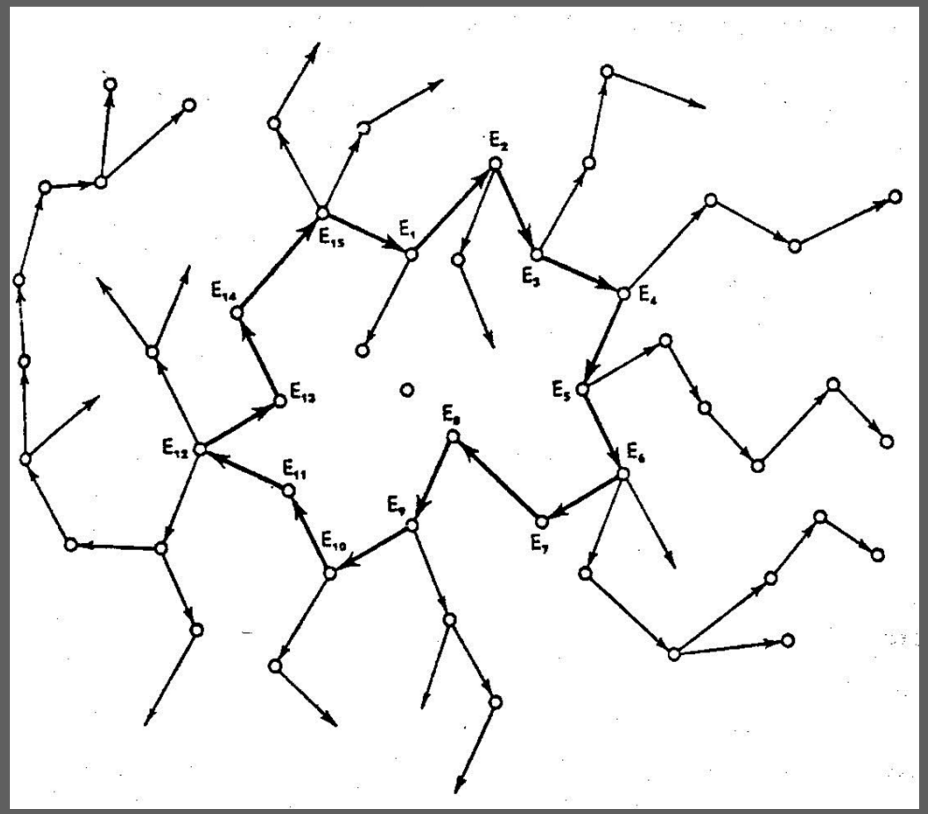


Wikipedia

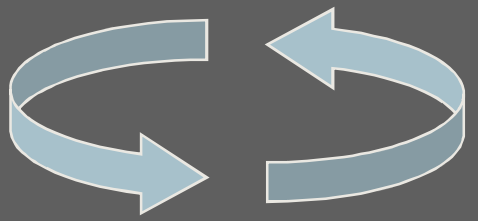
Belousovo Žabotinskio reakcija

Fermentų hiperciklai

With sufficient time and continuing flow of energy, catalytic cycles tend to interlock to form closed loops in which the enzymes produced in one cycle act as catalysts in the subsequent cycle and forming hypercycles. They are remarkably stabile and can persist under a wide range of conditions.



$$R \xrightarrow{p} p + b$$



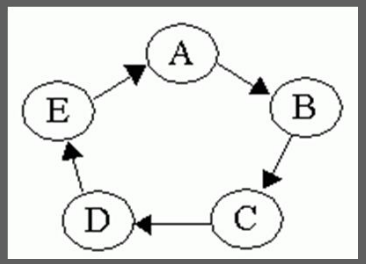
M.Eigen, 1971

Theory of the Chemical Hypercycle

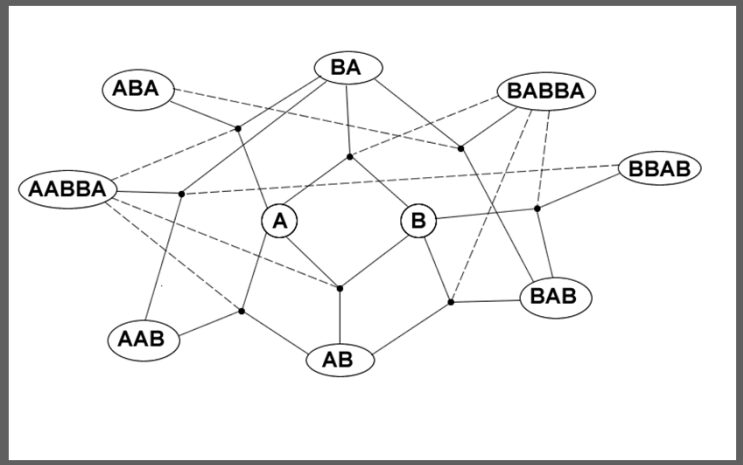
- Manfred Eigen

NP 1967

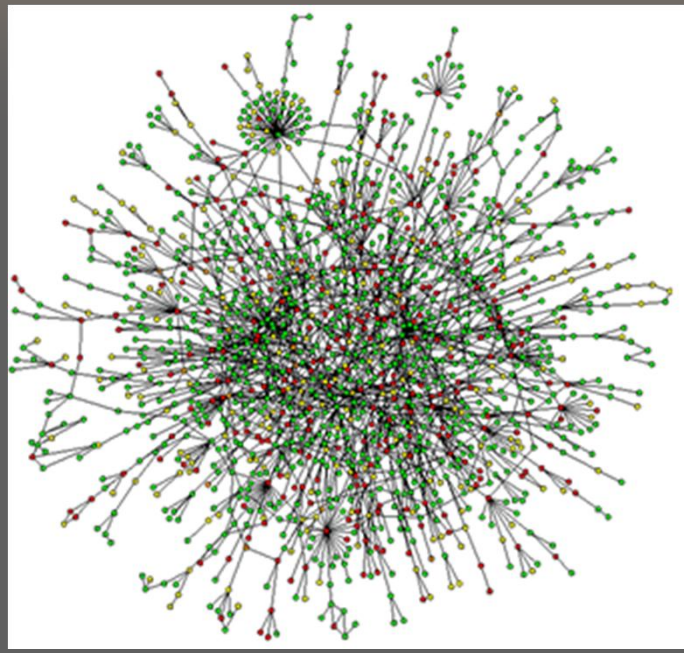
1979



Autocatalytic loop



A very simple autocatalytic set. Each node represents a ligation/cleavage reaction comprising three elements.



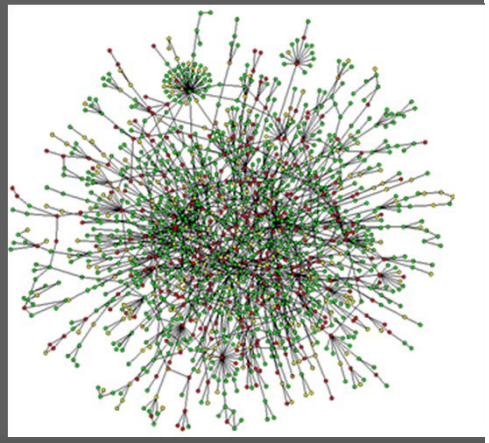
Map of protein-protein interactions.

- With sufficient time and continuing flow of energy, catalytic cycles tend to interlock to form closed loops in which the enzymes produced in one cycle act as catalysts in the subsequent cycle and forming hypercycles. They are remarkably stabile and can persist under a wide range of conditions.

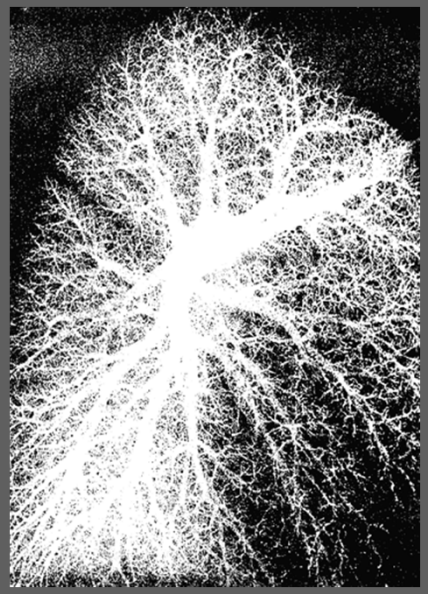
Autocatalytic chemical networks

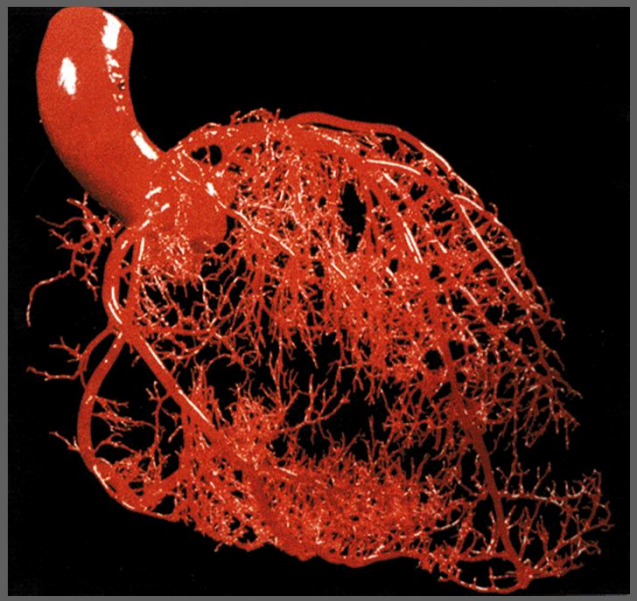
- According to Darwinian theory, living organisms formed out of “molecular chaos” by chance through random mutations. **However the probability of even simple cells to emerge is too small**.

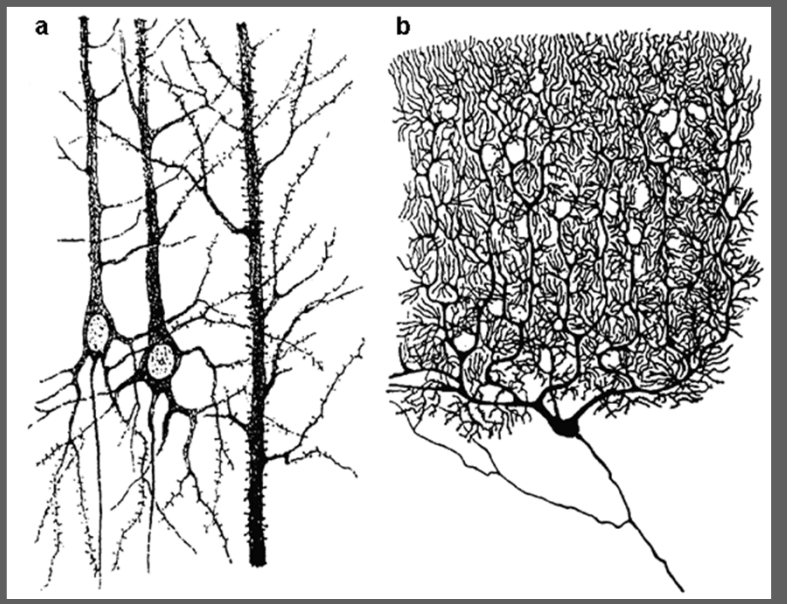
- **M.Eigen** proposed that origin of life may be the result of a processes of progressive organization in chemical systems far from equilibrium, involving hypercycles of multiple feedback loops. He postulated a prebiotic phase of evolution in which selection processes occur in the molecular realm (molecular self-organization).



Life is a Network of Interactions

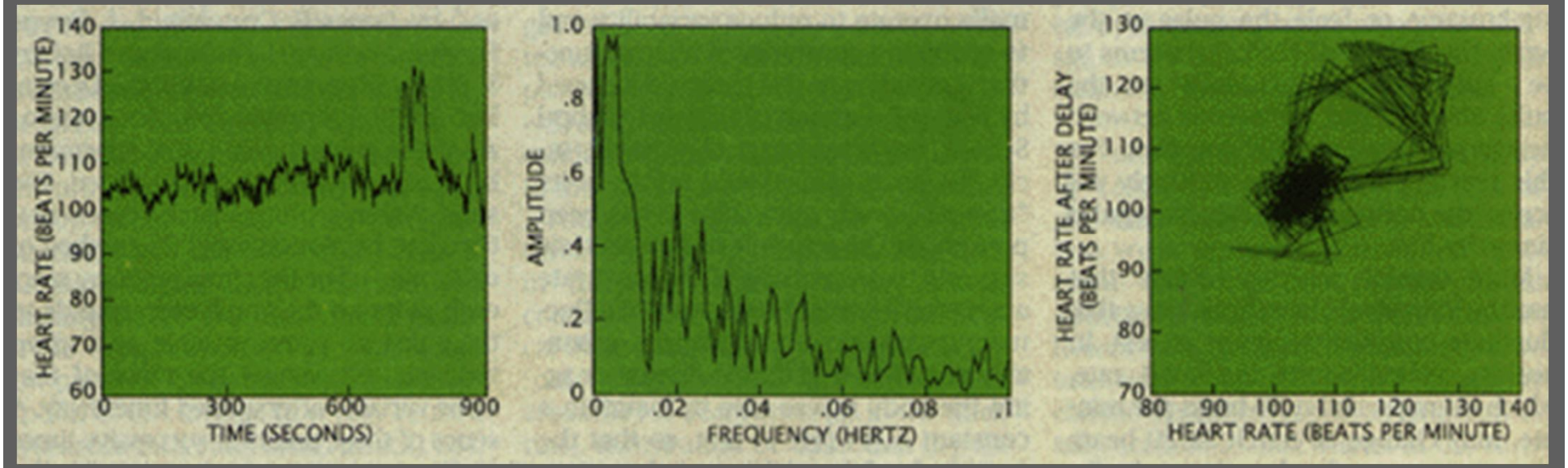






Functional dependence of cardiac rhythm

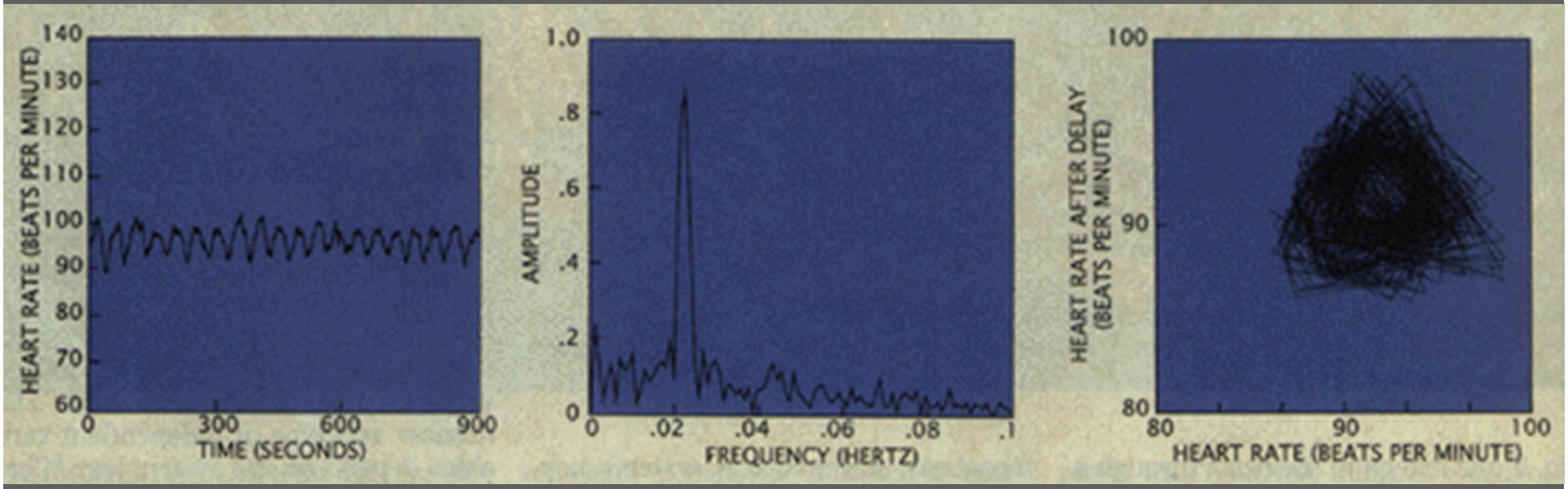
a healthy person



The left column shows the time dependence of cardiac pulse frequency, the middle column - the cardiac rhythm frequency (Fourier) spectrum, and the left column - the phase diagram characterising the nature of the attractor

Functional dependence of cardiac rhythm

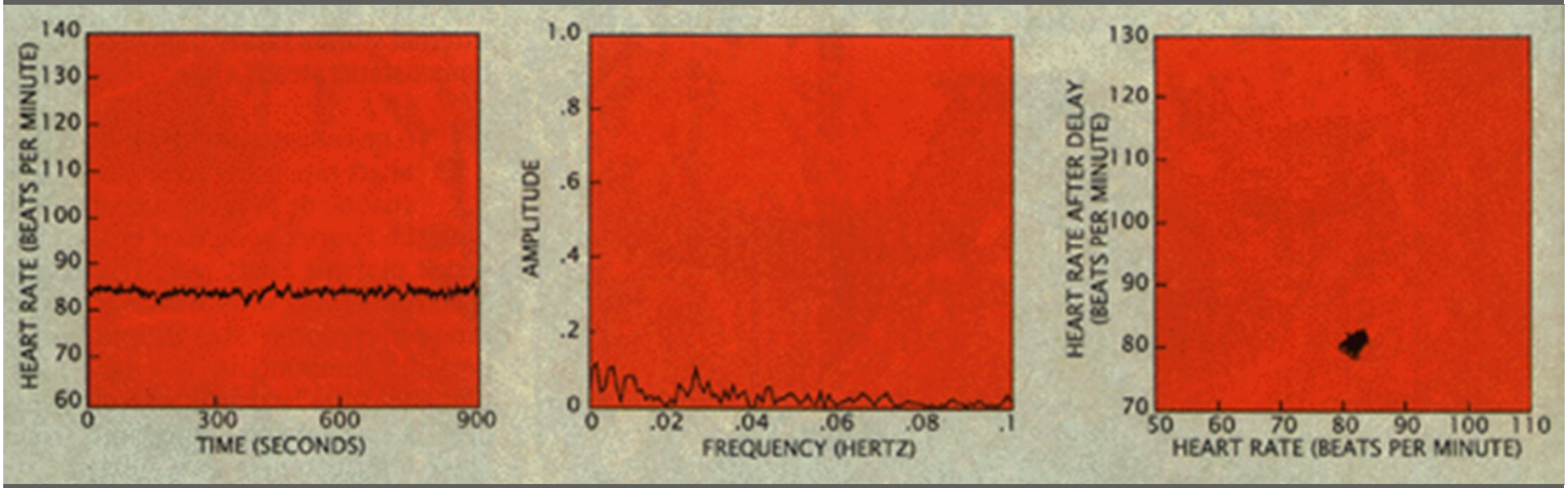
a person with heart disease after 8 days



The left column shows the time dependence of cardiac pulse frequency, the middle column - the cardiac rhythm frequency (Fourier) spectrum, and the left column - the phase diagram characterising the nature of the attractor

Functional dependence of cardiac rhythm

13 hours prior to a lethal infarction



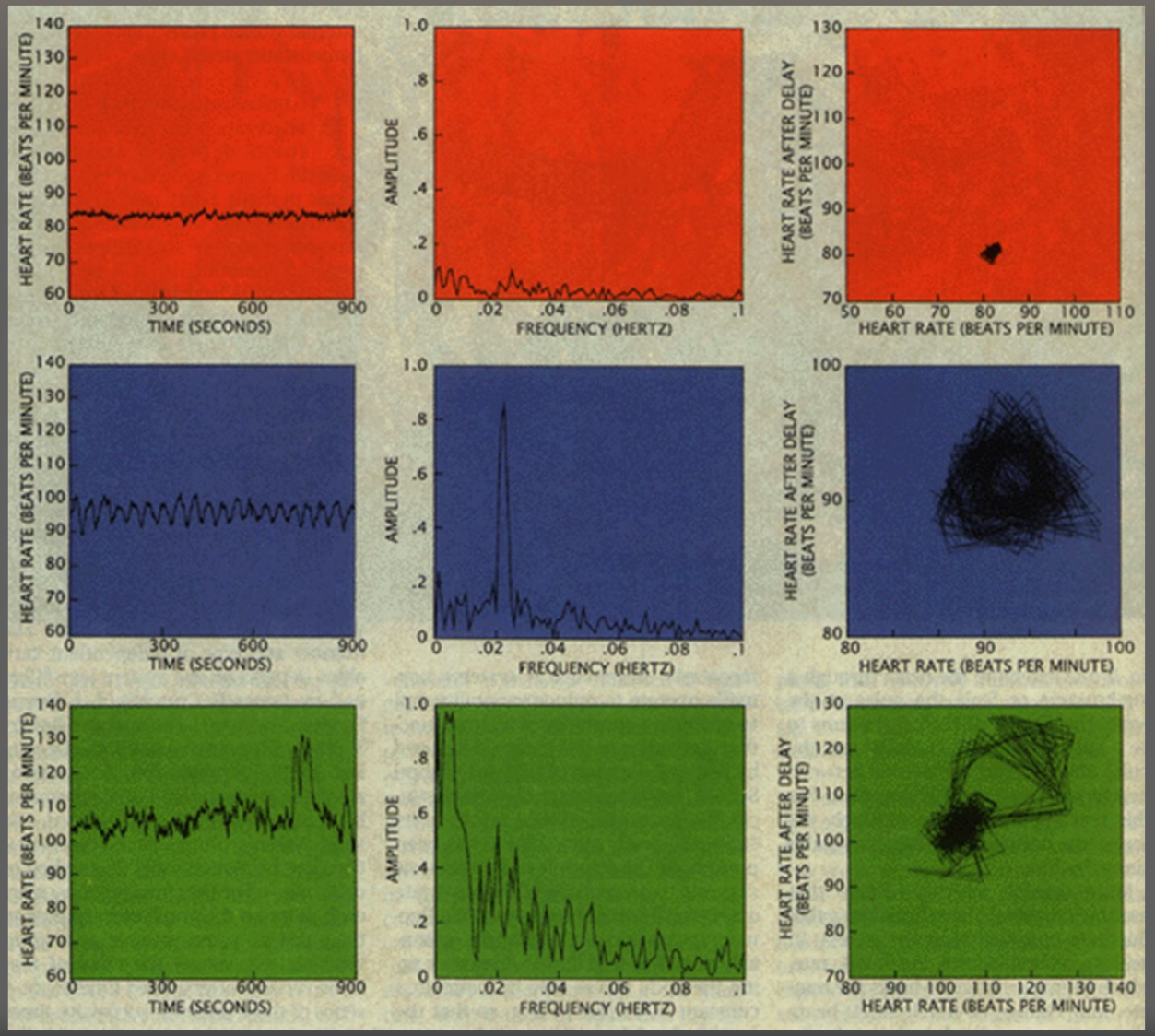
The left column shows the time dependence of cardiac pulse frequency, the middle column - the cardiac rhythm frequency (Fourier) spectrum, and the left column - the phase diagram characterising the nature of the attractor

Širdies ritmas

raudona- priešinfarktinė būsena (prieš 13 val.)

mėlyna- širdies liga (8 dienos prieš širdies smūgį)

žalia- sveikas žmogus



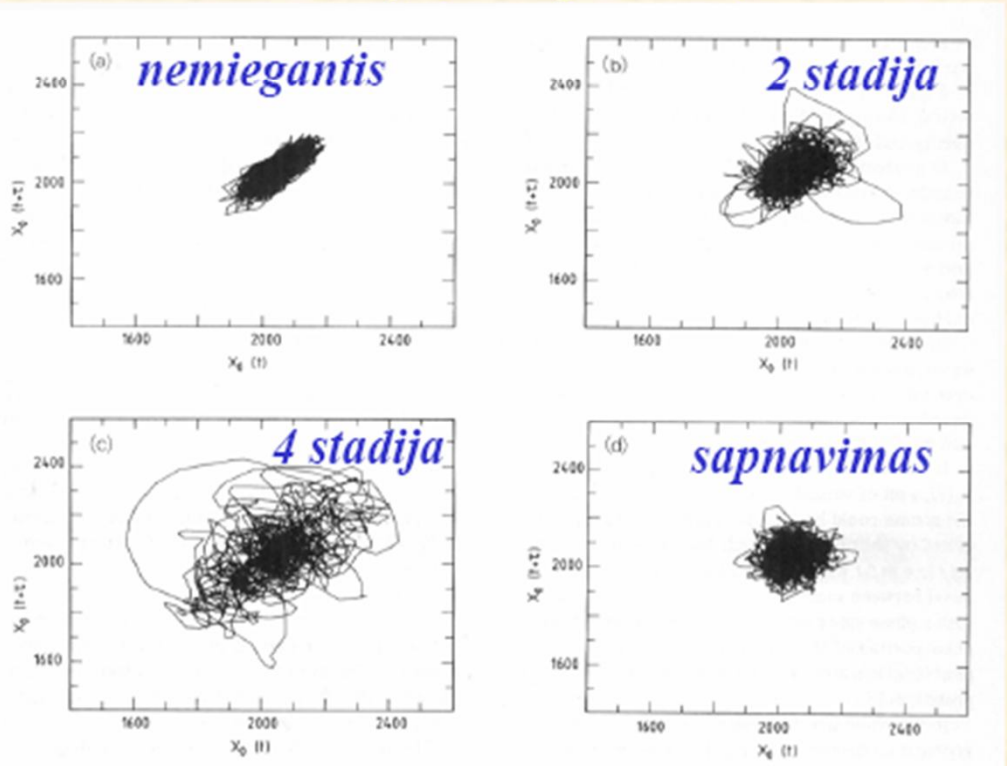
Pavyzdys: smegenų aktyvumo (EEG) dimensija miego metu

(A. Babloyantz, J.M. Salazar, C. Nicolis, Phyz. Lett. A, 111, 152,1983)

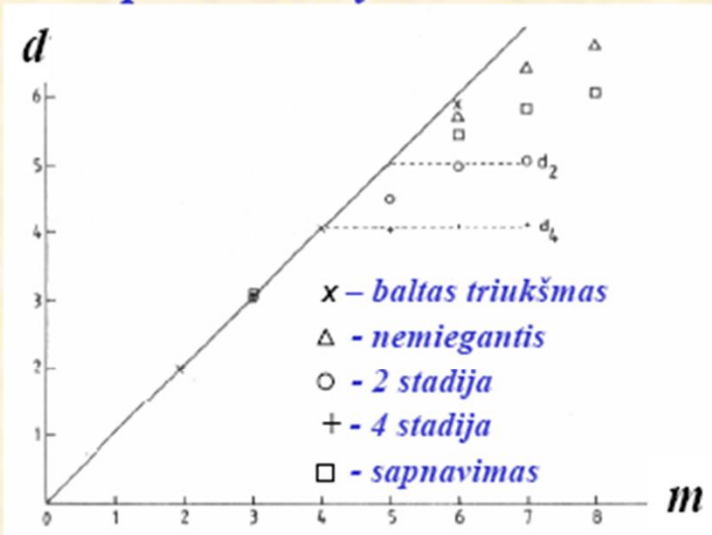
Miego stadijos:

1. *Pacientas periodiškai tai užmiega, tai pabunda*
2. *Miegantį galima pažadinti mažiausiu triukšmu*
3. *Miegantį galima pažadinti tik stipriu triukšmu*
4. *Gilus miegas*
5. *Sapnavimas (stebimas greitas akių judėjimas)*

Rekonstruoti EEG faziniai portretai, m=2.



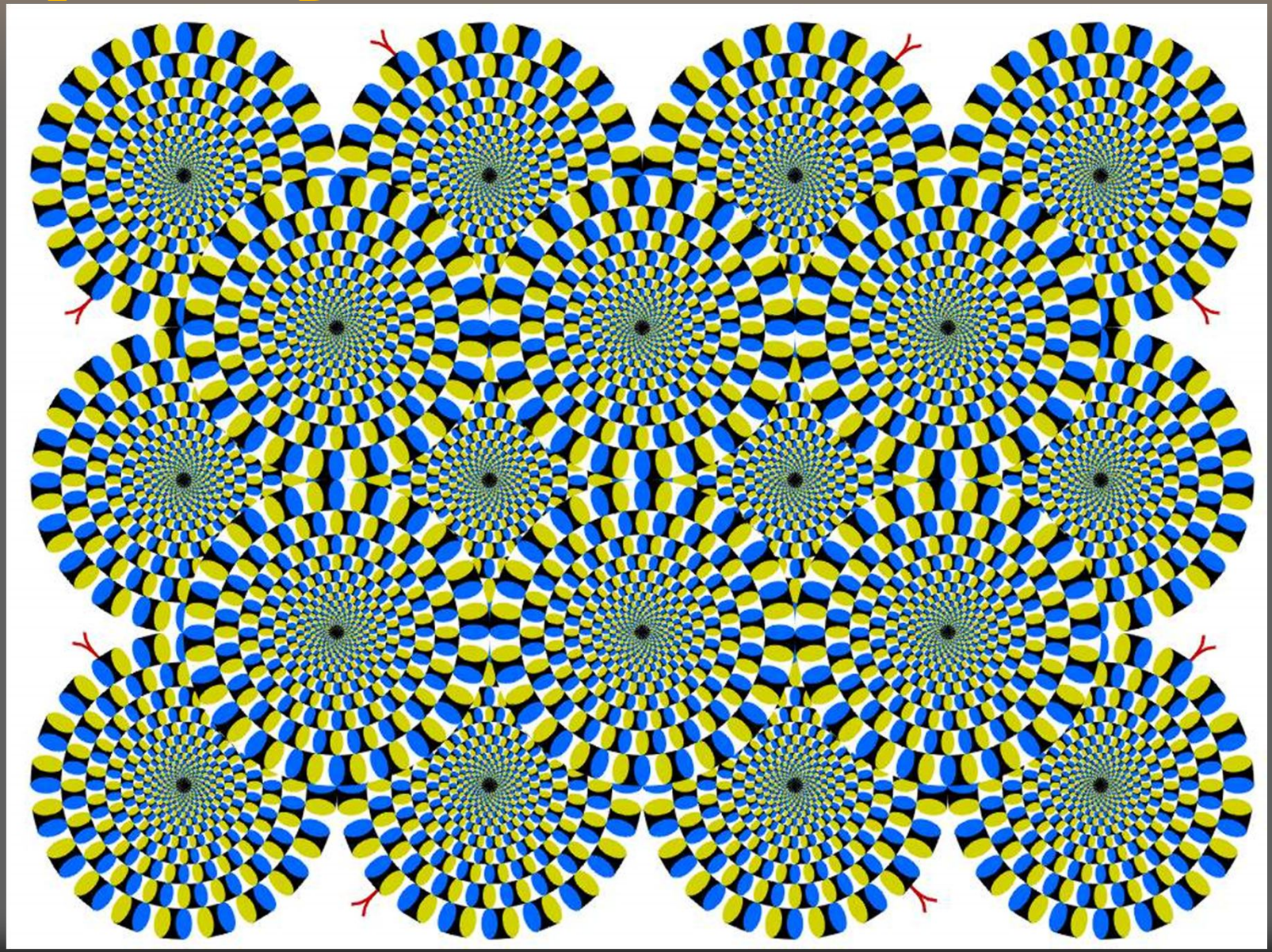
Koreliacinės dimensijos priklausomybė nuo m



Baigtinė dimensija stebima 2 ir 4 miego stadijoj: $d_2 \approx 5, d_4 \approx 4$

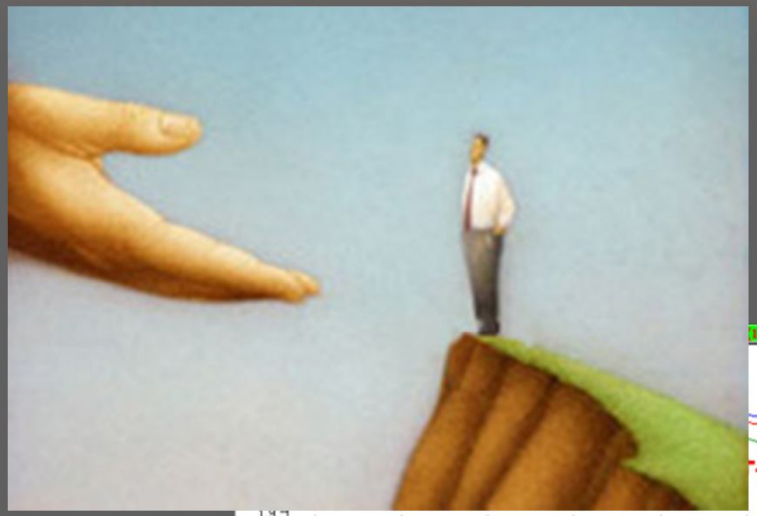
Pagal K.Pyragą

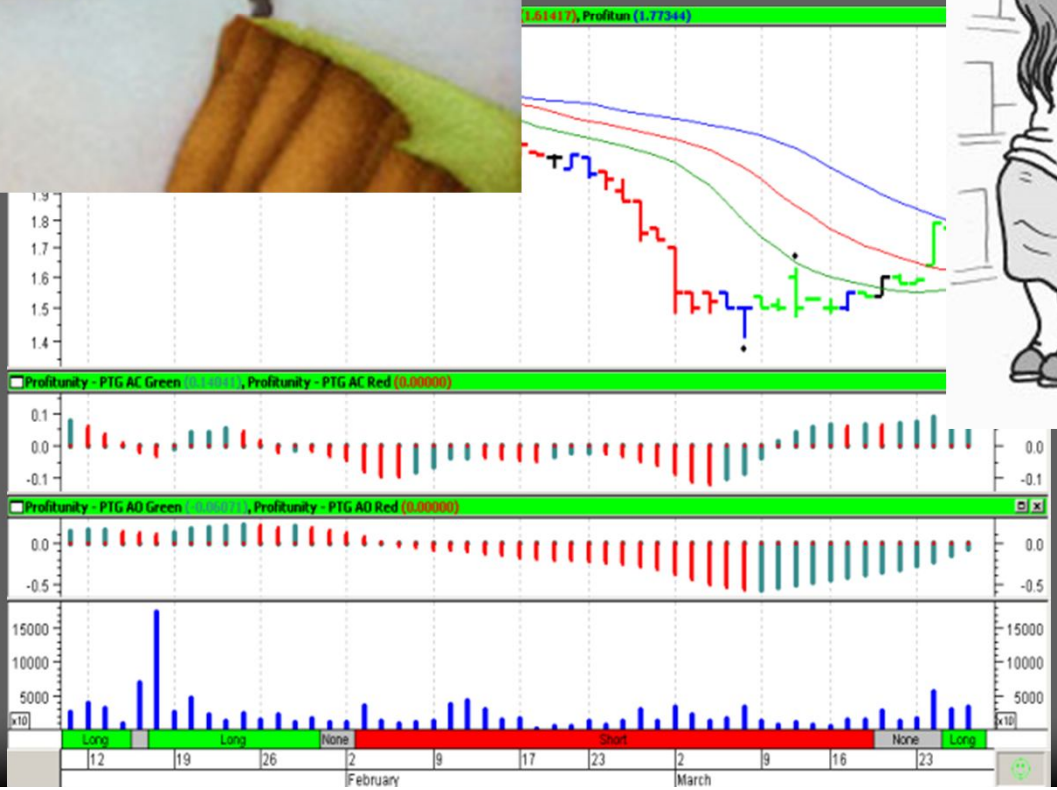
Adaptive systems



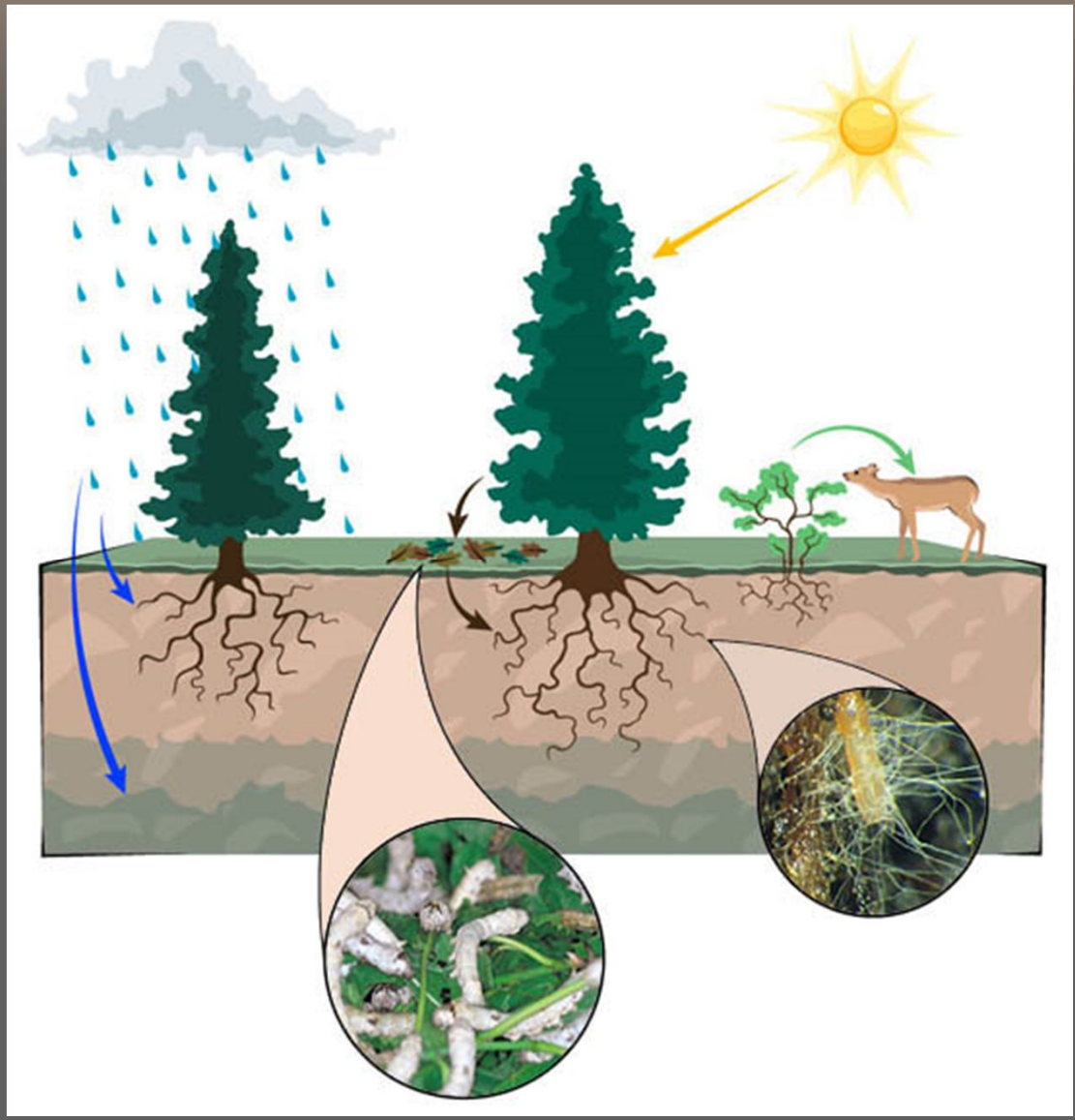
Teleonomic systems

Nematoma rinkos ranka

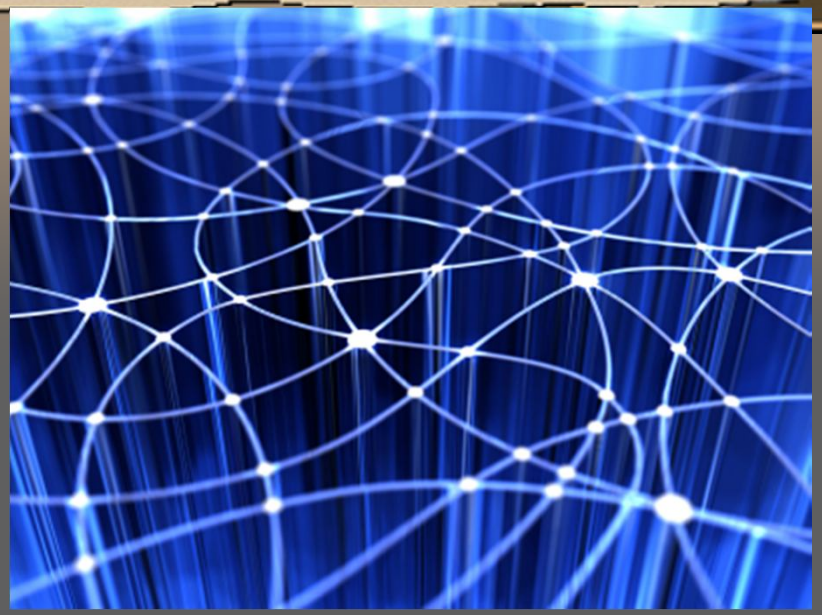




Ecosystem



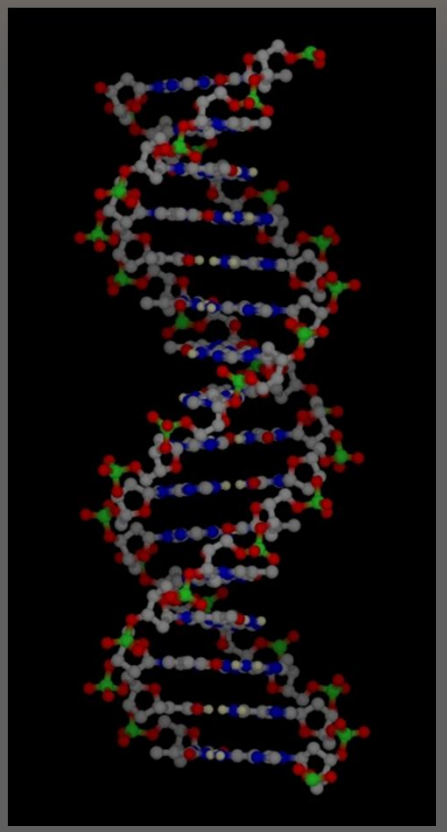
Networks



- Nonequilibriun systems with feedback relations might act teleonomic
- Chaotic dynamic systems with multiple feedback relations are adaptive
- Life is a self-generating network of communications

Cybernetics and informatics

- Life constitute autocatalytic, evolvable, teleonomic organic systems that can transfer, store, and process information …



Information

Biology and the II l. t.-d.

Entropy

Order

Information

Erwin Schrödinger was first to introduce the concept of negentropy

- negentropy characterises statistically the degree of order, i.e. a transition of the system from the more probable state (W_1) into a less probable one (W_2).

$$\Delta I = -\Delta S = -k \ln W_2 / W_1$$

- The increase in negentropy may be measured in statistical units, such as Joules (J), per unit temperature (degree), e.g. J / K.
- The negentropy equation opens a possibility of transition from these statistical units (J / K) to units of amount of information, i.e. to bits.
- This makes it possible to assess, say, the amount of "accumulated" information in DNA or protein molecule.

Information Transfer

Shannon–Hartley theorem

$$C = B \log_2 \left(1 + \frac{S}{N}\right)$$

C is the channel capacity in bits per second;

B is the bandwidth of the channel in hertz (passband bandwidth in case of a modulated signal);
S is the total received signal power over the bandwidth (in case of a modulated signal, often denoted *C*, i.e. modulated carrier), measured in watt or volt2;
N is the total noise or interference power over the bandwidth, measured in watt or volt2; and
S/N is the signal-to-noise ratio (SNR) or the carrier-to-noise ratio (CNR) of the communication signal to the Gaussian noise interference expressed as a linear power ratio (not as logarithmic decibels).

Entropy Measure of information

Claude Shannon 1948

A key measure of information in a message is **entropy**, which is usually expressed by the average number of bits needed for storage or communication.
For equally probable system Shanon entropy (in bits) is the number of yes/no questions to reveal the content of the message

Information entropy *H*

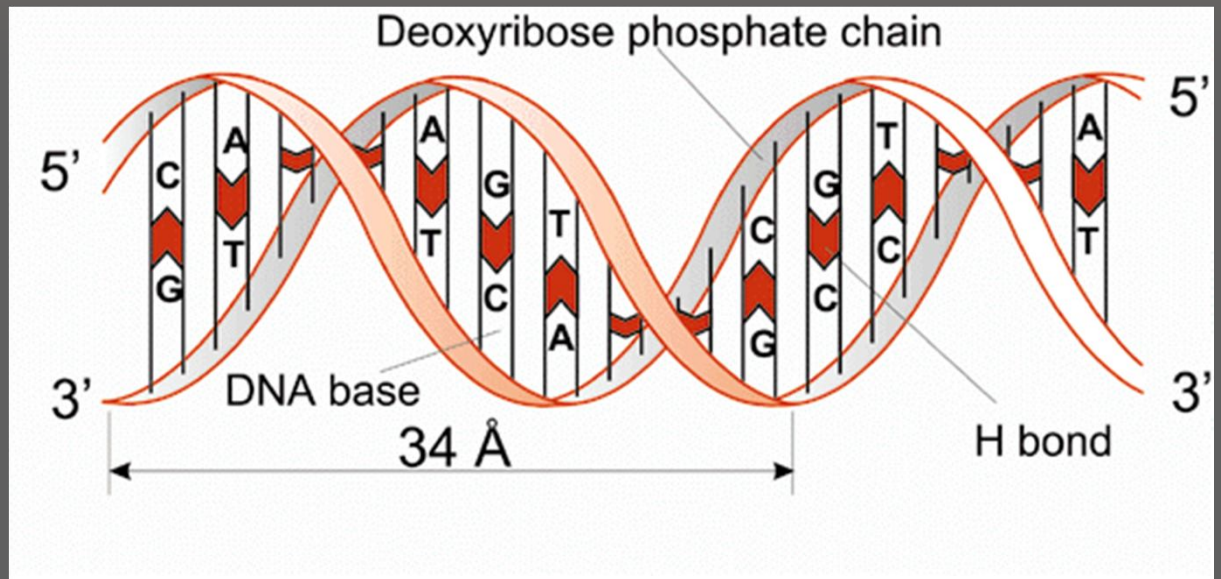
$$H = K \ln(1/p)$$

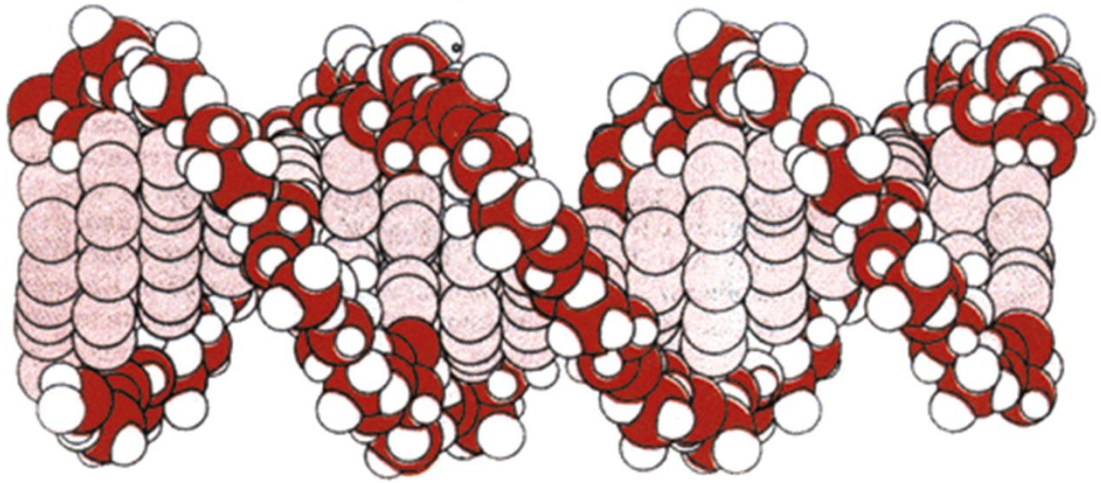
In bits

K=1/ln(2)

Desoxyribonucleic acid (DNA) macromolecule

Genetic information is inscribed in the four-letter alphabet of DNA bases (A, T, G, C). The basic element - the codon is formed by a triplet of 3 DNA bases. The DNA "alphabet" contains 64 triplet "letters", each triplet coding a definite amino acid and determining their sequence in the synthesis of protein macro-molecules.





Information and Entropy

- Information (negentropy) defines the capacity to store and transmit meaning or knowledge, not the meaning or knowledge itself
- This definition is analogous to the operational definition of energy as the capacity to do work
- Meaning and knowledge are historically formed and depend on context

Theory of information elucidates complex phenomena in living Nature

- Twenty alternatively chosen questions equal 20 bits of information. This means that we may find the object in question out of 2^{20} = 1048576 alternatives, i.e. out of more than a million possible answers.
- The enzymes acting in living organisms require 15 to 17 bits of information for definite identification of the substrate, the molecular structure of which is its complementary opposite, like lock and key.
- In the case of 15 bits the enzyme is capable of identifying the substrate among more than 32000 alternative compounds.
- For the identification of a specific smell out of the smells of a thousand people, the dog needs 10 bits of information (2^{10} = 1024).

ACCUMULATION OF INFORMATION IN LIVING NATURE

- The protein macromolecule, which consists of 1000 amino acids may contain about 4×10^3 bits of information.
- A DNA macromolecule, which consists of 4000 nucleid bases, may contain about 8×10^3 bits of information.
  - This amount of information corresponds to about one page of printed text, which may contain ca. 10^4 bits.
- The E. coli microbe cell may contain 10^{12} bits of information.
  - 10^{12} bits equal 10^8 pages of text, or, one million (10^6) books with a hundred pages each.
  - This means that the amount of information in a E. coli microbe is of the same order as the overall number of books in the largest libraries of the world!
- “Text" of a human genome may contain about 6×10^9 bits of information.
  - If we want to express it in the terms of the number of printed pages that would mean 6×10^5 pages of text.

Genetic code of a simplest micro-organism the bacterial fague ΦX 174, included in the chain of a DNA macro-molecule

This text contains 1800 triplet "letters" (codons), which read in the usual manner, from left to right, line after line. This text illustrates the philosophical thought of the Gospel according to St. John: "In the beginning was the Word".

Fizikiniai gyvųjų sistemų bruožai

- Nepusiausviroji sistema, veikianti prieš II termodinamikos dėsnį. Sistema, atvira medžiagai ir energijai, tačiau atsiskyrusi nuo aplinkos.
- Paklūstanti netiesinei dinamikai istorinė sistema. Savitvarkė, autopoetinė save atkurianti sistema.
- Chaosinė, fraktalinės dimensijos
- Teigiamų ir neigiamų grįžtamųjų ryšių tinklas (apimantis ir sąveiką su aplinka). Valdymas, teleonominė - siekianti tikslo sistema. Komunikuojanti sistema
- Pažįstanti sistema, keičianti savo struktūrą sąveikaujant su aplinka. Gyvybės vyksmai – pažinimo vyksmai