

MAI4CAREU

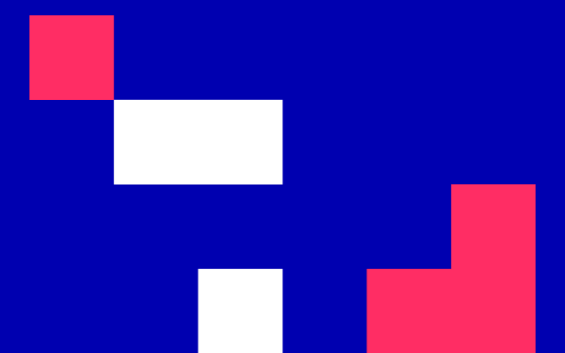
Master programmes in Artificial
Intelligence 4 Careers in Europe

University of Ruse

INTELLIGENT COMPUTER SYSTEMS

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INTRODUCTION INTO INTELLIGENT SYSTEMS

1. Introduction
2. Genome
3. Intellect
4. Artificial intelligence
5. Intelligent system
6. History
7. Intelligent system popularity today

Why do we study this discipline?

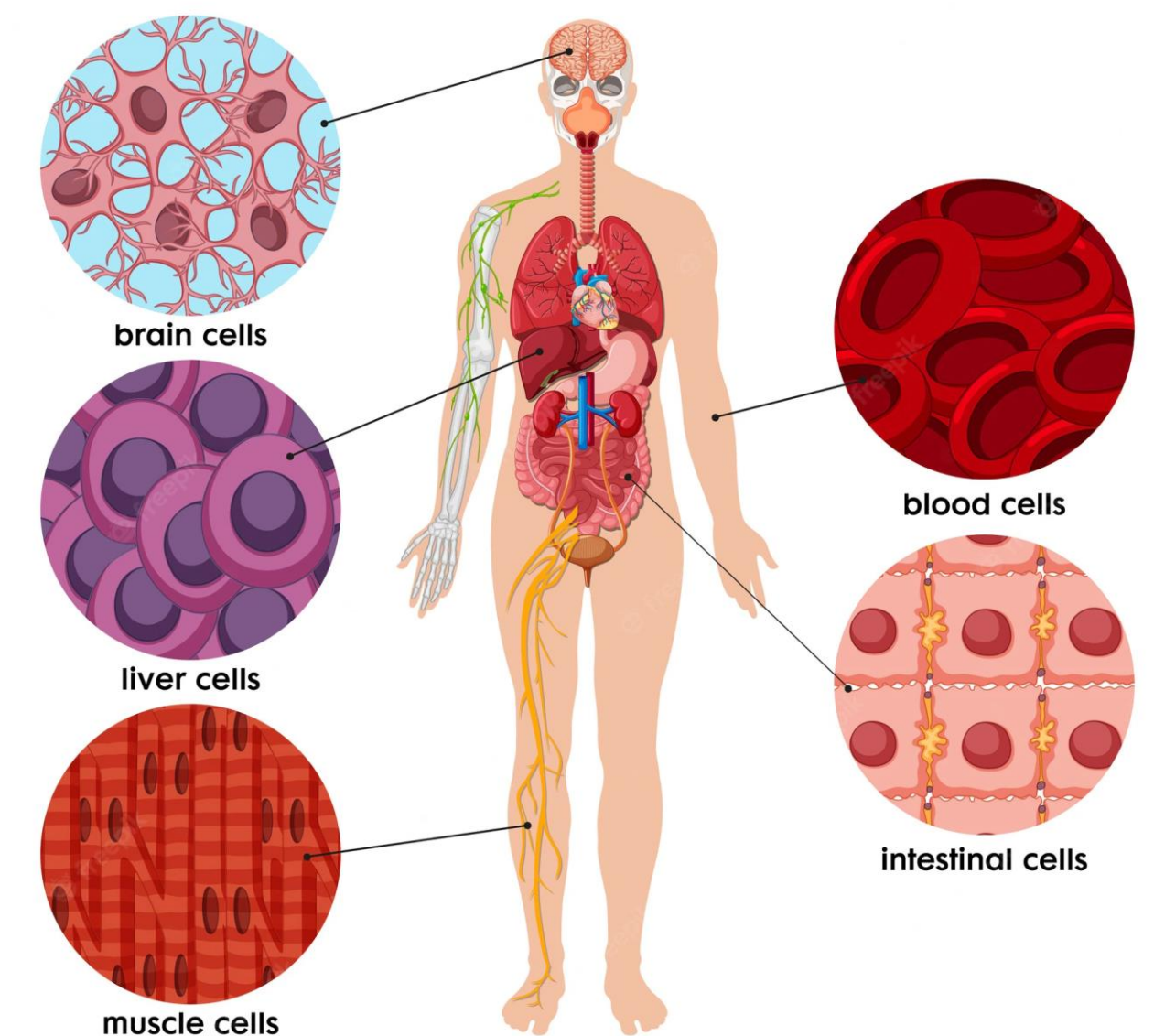


CONTENT 1

The human body

- 100 trillion **cells** – most with a size across less than 0.01mm;
- each cell has a **core** inside;
- inside the core there are **2 sets of the human genome** (1 from the mother and the father each) – excluding eggs and sperm cells with 1, and red blood cells – without.

Cells of The Human Body



CONTENT 2

Genome („book“)

A set of instructions for construction and management of the human body.

- **23 chromosomes („chapters“)** – a pair of DNA molecules;
- **30-80 000 genes („stories“)** – one-dimensional digital codes:
 - **Exons** – logical informational paragraph;
 - **Introns** – illogical paragraphs;
- Each paragraph consists of **codons („words“)** – 3 letter (64 combinations);
- Each codon consist of **bases („letters“)** – 4: A, C, G and U;
- 20 amino acids;

CONTENT 2

Genome - operations

- Reading/translation;
- Copying/replication.

History:

On 26/06/2000 Bill Clinton and Tony Blair simultaneously announce that the preliminary version of the human genome is ready.

CONTENT 2

Genome - determination

Humans are determined by the instructions of our genes, but what we learn in our lives defines us even more.

- Genome is a computer that processes information.
- Natural selection is a process of extracting useful information from the surrounding environment and encoding it into genes. This is a slow process – generations are necessary for each change.

CONTENT 2

Genome and the brain

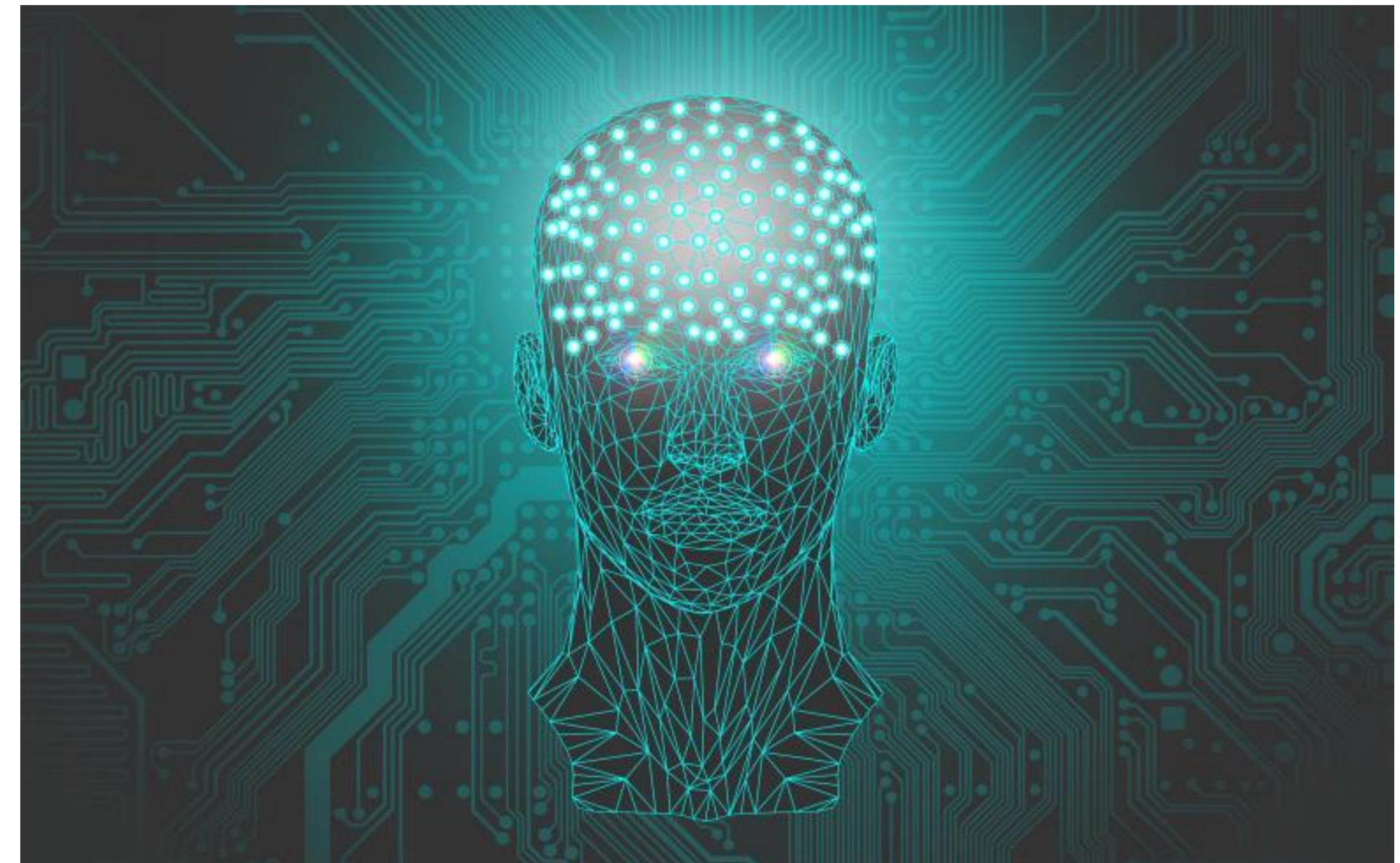
The genome has discovered a much faster and more useful machine that, in a matter of minutes or seconds, can extract information from the world around it and realize that information through behavior. This machine is **the brain**.

Example: Our genome gives us the nerves which tell us when we burned our hand, our brain gives us the action to remove our hand from the stove.

CONTENT 3

What is intellect?

- How quick the mind is?
- The ability to reflect?
- Memory?
- Vocabulary?
- Mental calculation?
- Spiritual energy?
-



CONTENT 3

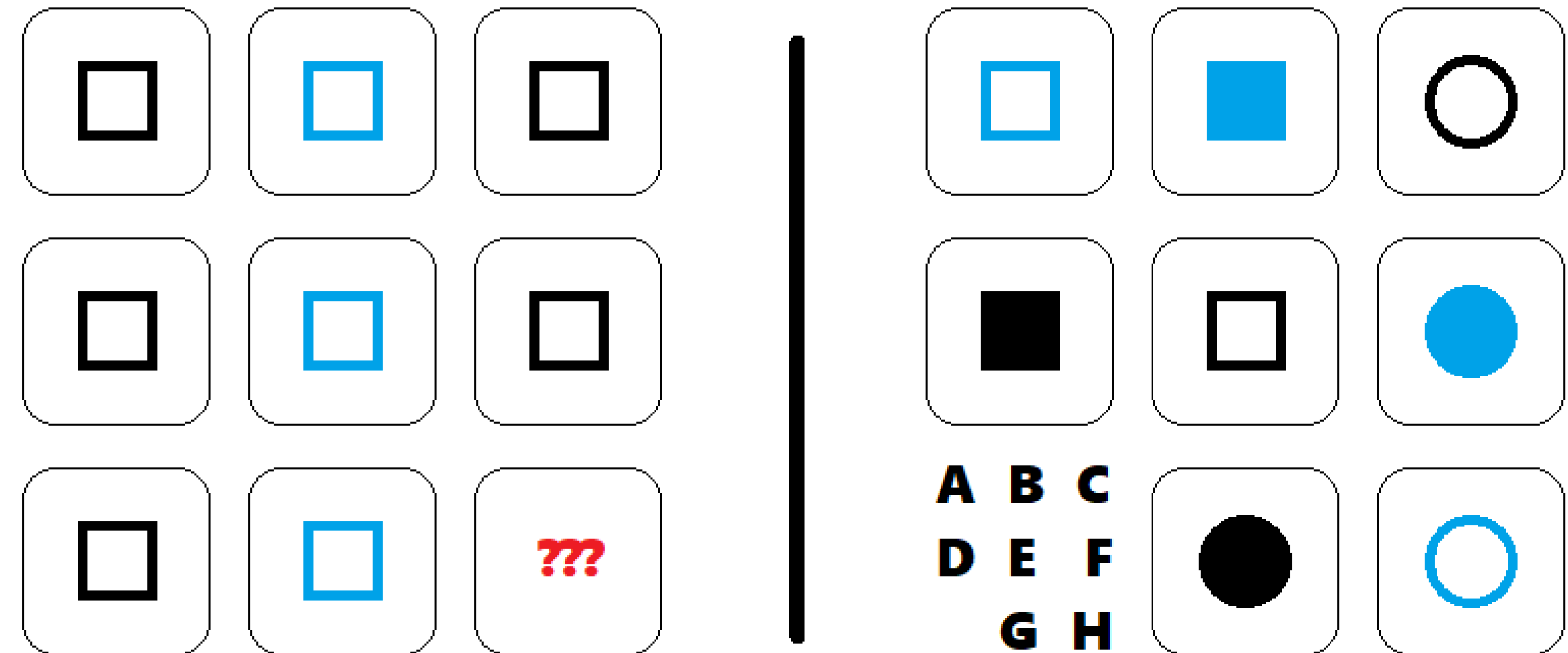
Intellect - theories

- About the **multiple intelligence** – each talent is a separate ability.
- About the **3 types of intelligence**:
 - **analytical** - analytical tasks are clearly formulated by someone else, carry all the information necessary to solve them and have only 1 correct answer, are not directly related to everyday life and are not interesting outside themselves;
 - **creative**;
 - **practical** - practical tasks require you to recognize and formulate them, they are not strictly defined, they lack some essential information, they may or may not have 1 single correct answer, they come directly from everyday life.

CONTENT 3

IQ (Intelligence Quotient) tests – what is determining?

- congenital abilities?
- education?



CONTENT 3

IQ tests

- Directed towards analytical problems;
- Oriented towards a specific frame of mind;

CONTENT 3

IQ inheritance?

The hypothesis is checked upon 2 groups: twins and adopted

- Single human, tested twice – 87% proximity;
- Identical twins, who grew up together – 86% proximity;
- Identical twins, who grew up separately – 76% proximity;
- Fraternal twins, who grew up together – 55% proximity;
- Biological brothers and sisters – 47% proximity;
- Parents and children, who live together – 40% proximity;
- Parents and children, who live separately – 31% proximity;
- Adopted children, who live together – 0% proximity;
- Unrelated people, who live separately – 0% proximity.

Conclusion-hypothesis: You do not inherit IQ, but the ability to develop a high IQ under certain environmental conditions.

CONTENT 3

Intellect - definition

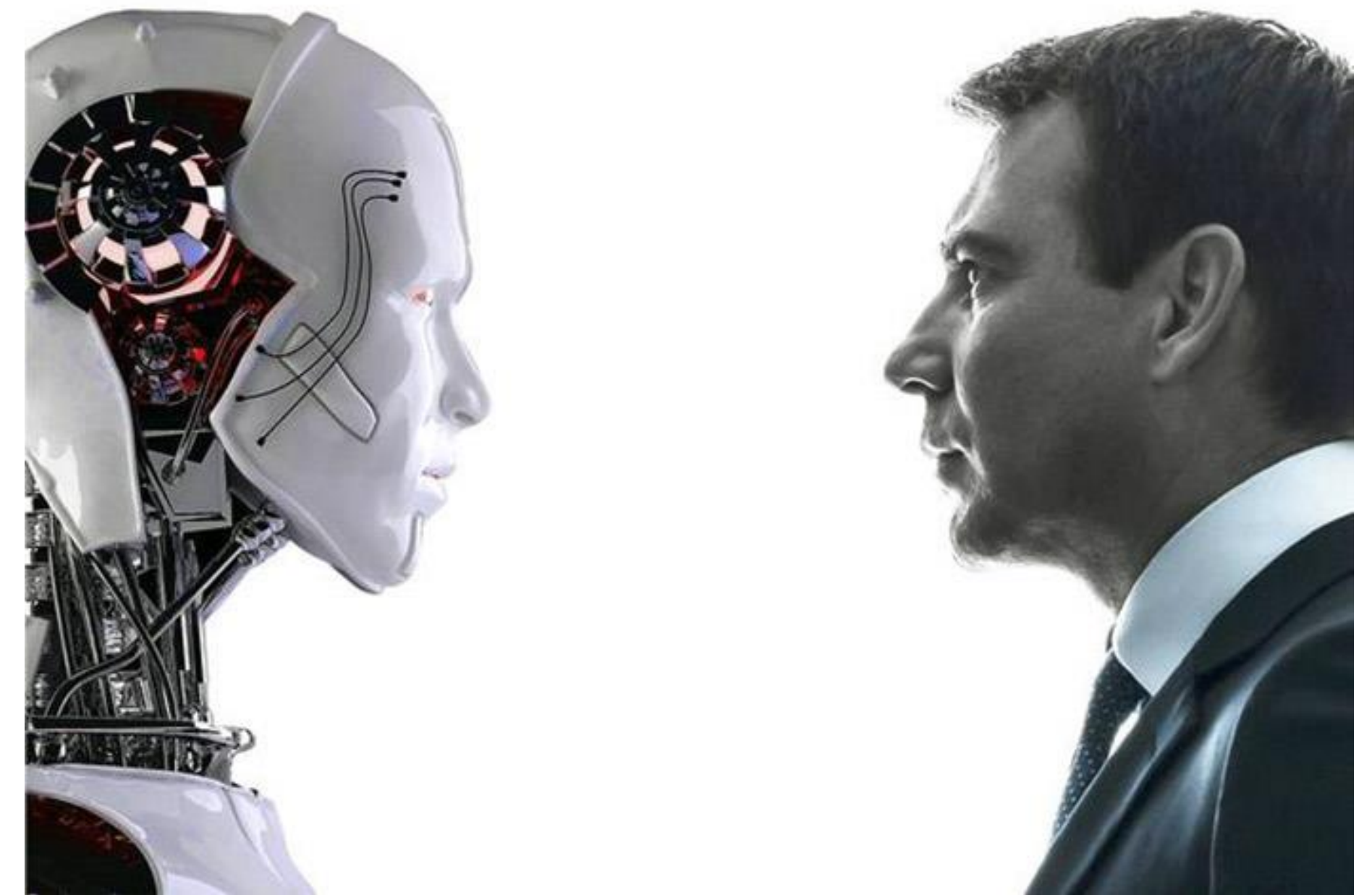
A set of specific capabilities of each self-organizing system to generate strategies to extract, formulate, and use knowledge in purposeful behavior in unknown problem situations.



CONTENT 3

Types of intellect

- natural;
- artificial.



CONTENT 3

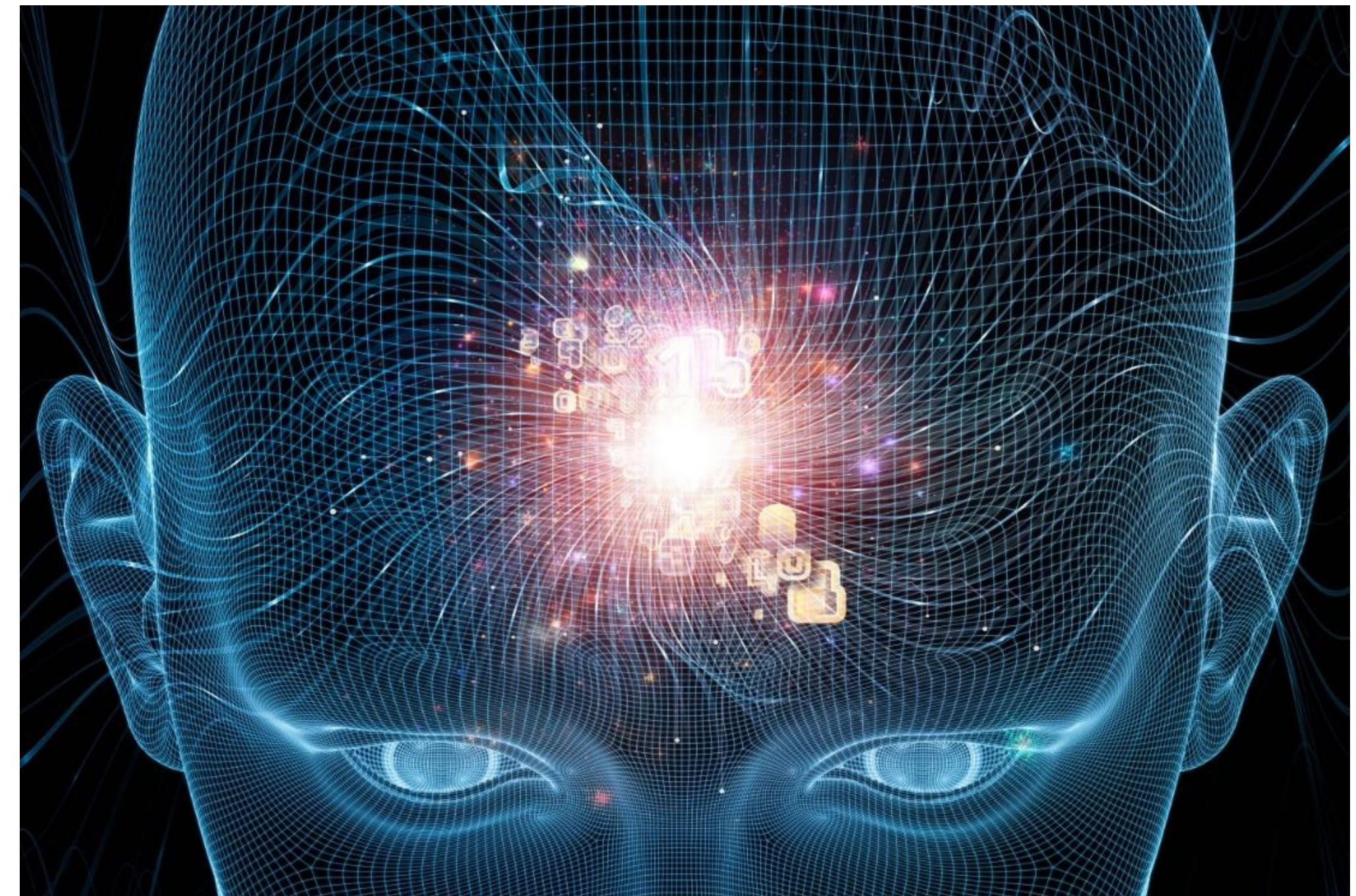
Natural intellect



CONTENT 4

Artificial intelligence

- concept - **Artificial Intelligence (AI)**;
- introduced by John McCarty in **1956**;
- reason – different projects, designed to get computers to think and learn.



CONTENT 4

Artificial intelligence

„ **Artificial Intelligence (AI)** is the science of concepts that allows computers to do things that seem reasonable to humans”.
(P. Winston)



CONTENT 4

Advantages of natural intelligence from computer science's perspective

- Parallel organization of the brain;
- Proven difference in the specialization of the right and left hemispheres of the brain;
- The human brain is made up of neurons, organized into a complex network;
- The search for information in the brain happens through the associative principle;

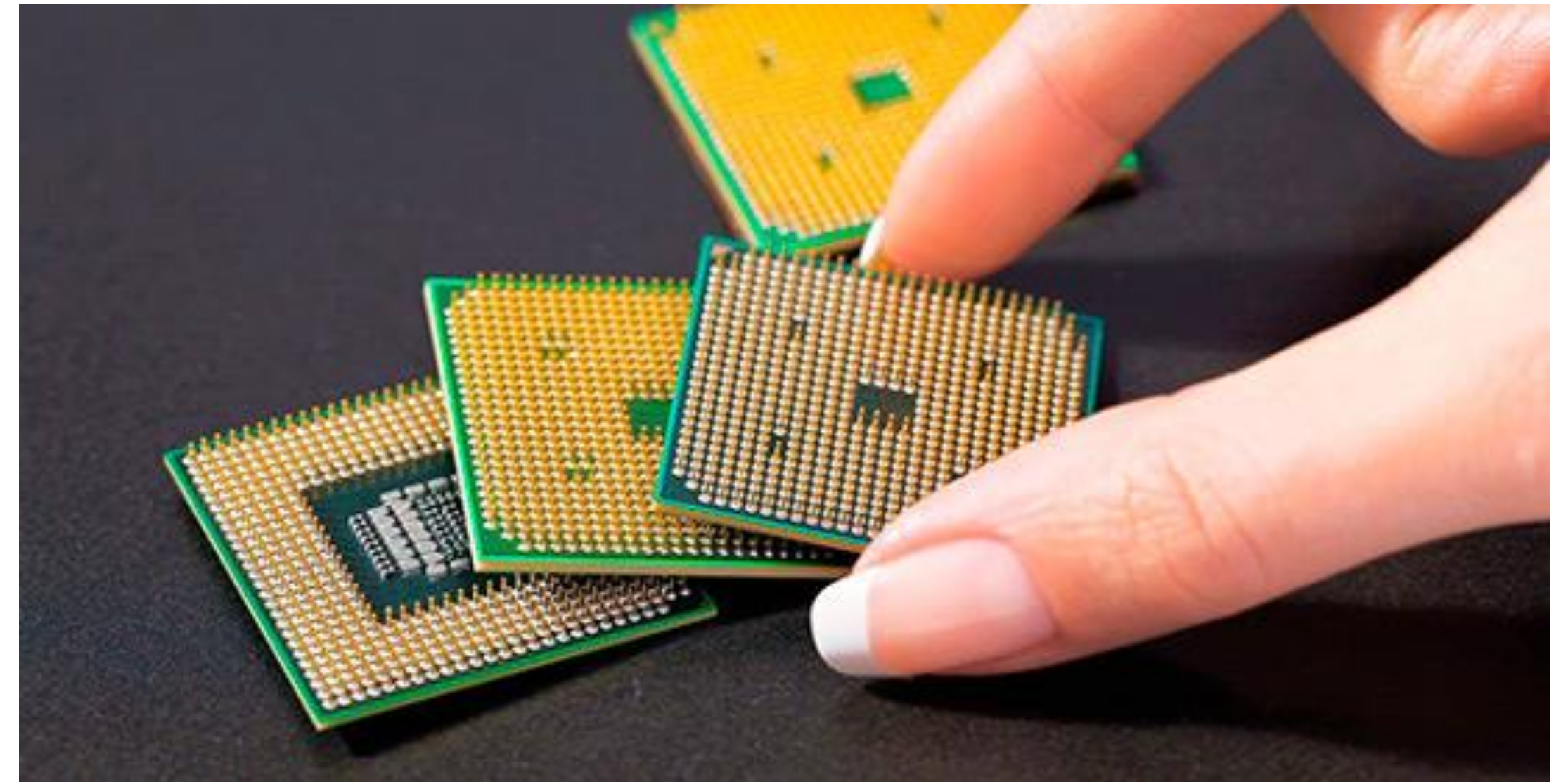


CONTENT 4

Advantages of natural intelligence from computer science's perspective

Parallel organization of the brain – using this feature, multi-core processors and parallel computers were created.

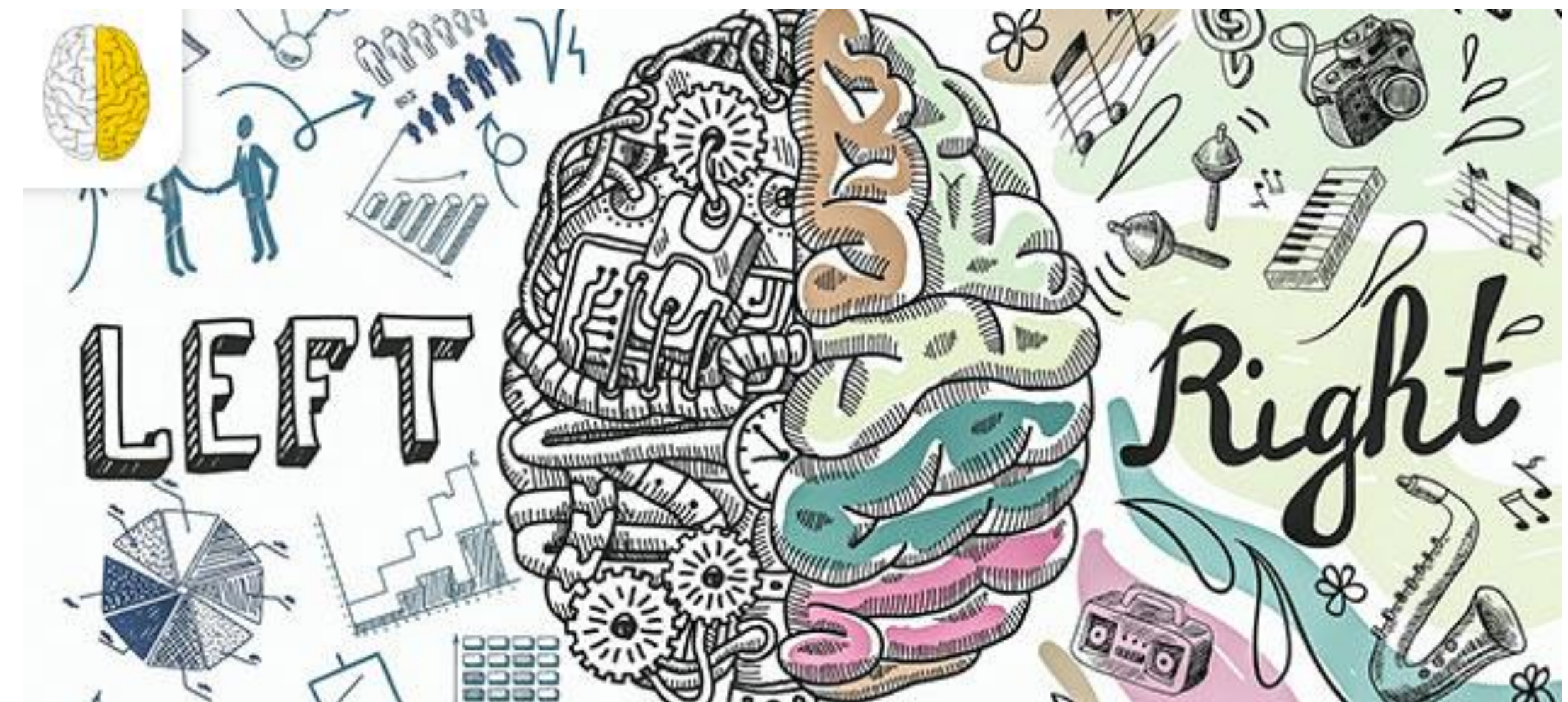
NPU (neuron processing unit) - part of the processor responsible for processing tasks related to AI.



CONTENT 4

Advantages of natural intelligence from computer science's perspective

Proven difference in the specialization of the right and left hemispheres of the brain (the right is mostly responsible for the imaginary thinking and the left - for the symbolic) – separating the video processing to the video card.



CONTENT 4

Advantages of natural intelligence from computer science's perspective

The human brain contains over 10^{11} neurons and each one is in contact/connection with a range from 10^4 to 10^{10} other neurons – this fact determines the contours of the new generation computers and nets.

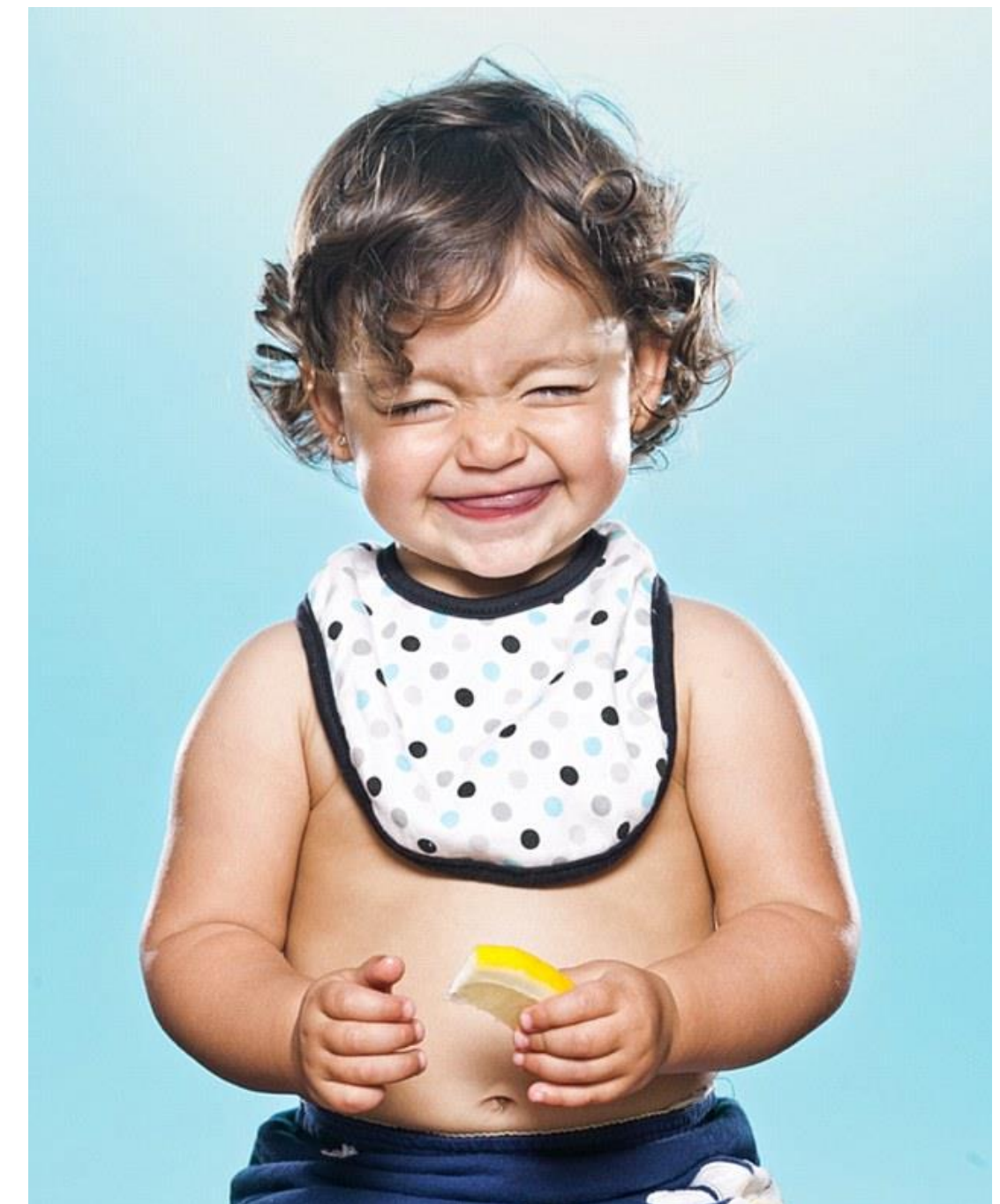
Proven layered architecture.



CONTENT 4

Advantages of natural intelligence from computer science's perspective

The search for information in the biological memory happens through **the associative principle** – a transition begins from address memory devices to associative.



CONTENT 5

Intelligent system (IS)

- complex adaptive system;
- makes rational decisions and can be self-taught.

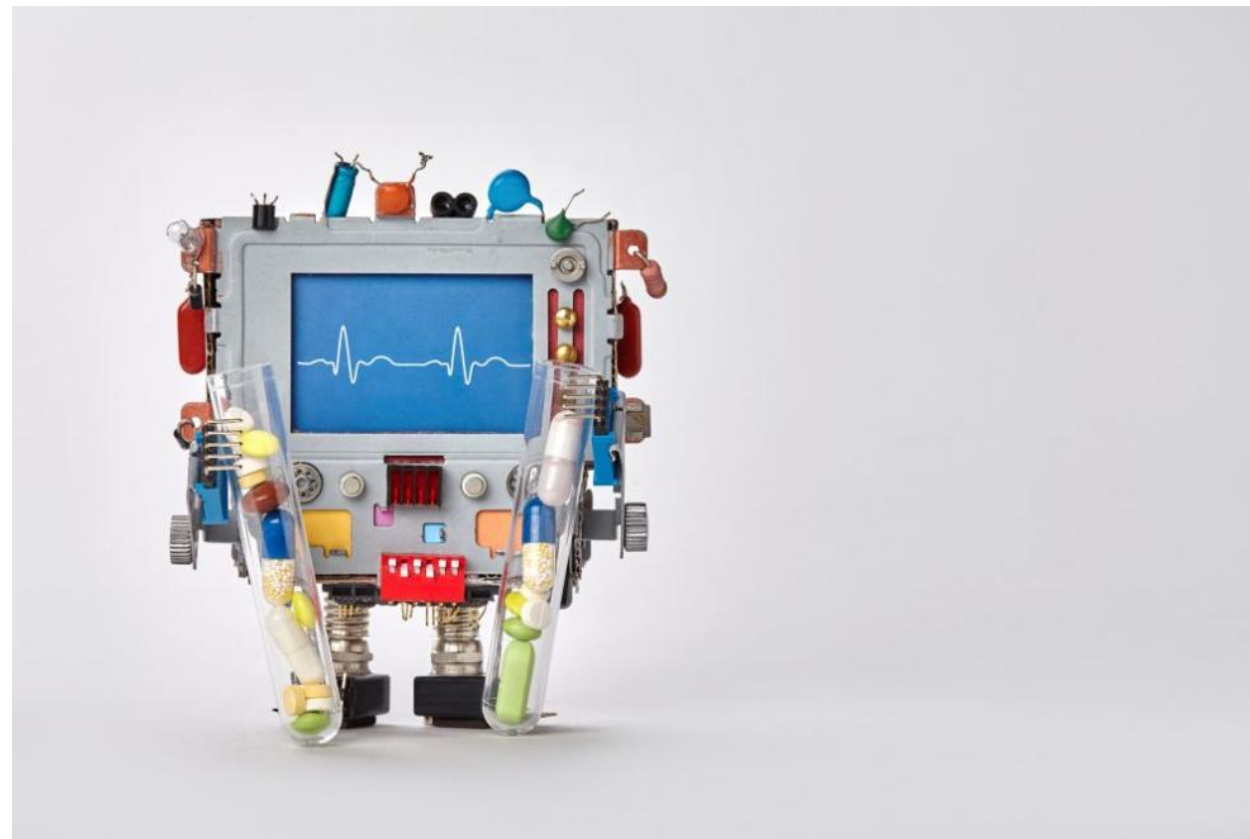
Has:

- senses;
- executive mechanisms;
- goal – to reach it, it chooses an action based on its experience and knowledge.

CONTENT 5

Examples of intelligent systems

- human;
- higher animals;
- computer;
- robot;
- other



CONTENT 5

Intelligent computer system (ICS) - features

- **Uses software algorithms with cognitive abilities similar to those of humans** (planning, self-learning, pattern discovery in random data, etc.).
- **Differs from the traditional software.**
- **Requires hardware computing power and data.**

CONTENT 5

ICS vs standard computer system

- **Standard program** - implements a given processing algorithm;
- **Intelligent system** - makes conclusions using a knowledge base. AI algorithms must be able to recognize and react to unexpected circumstances not foreseen by the programmers.

CONTENT 5

Real ICS

Just a tool that, in contrast to fantasy films, only helps and complements people, processing huge amounts of data with precision and speed, sometimes inaccessible to human abilities.

CONTENT 6

History – industrial revolutions

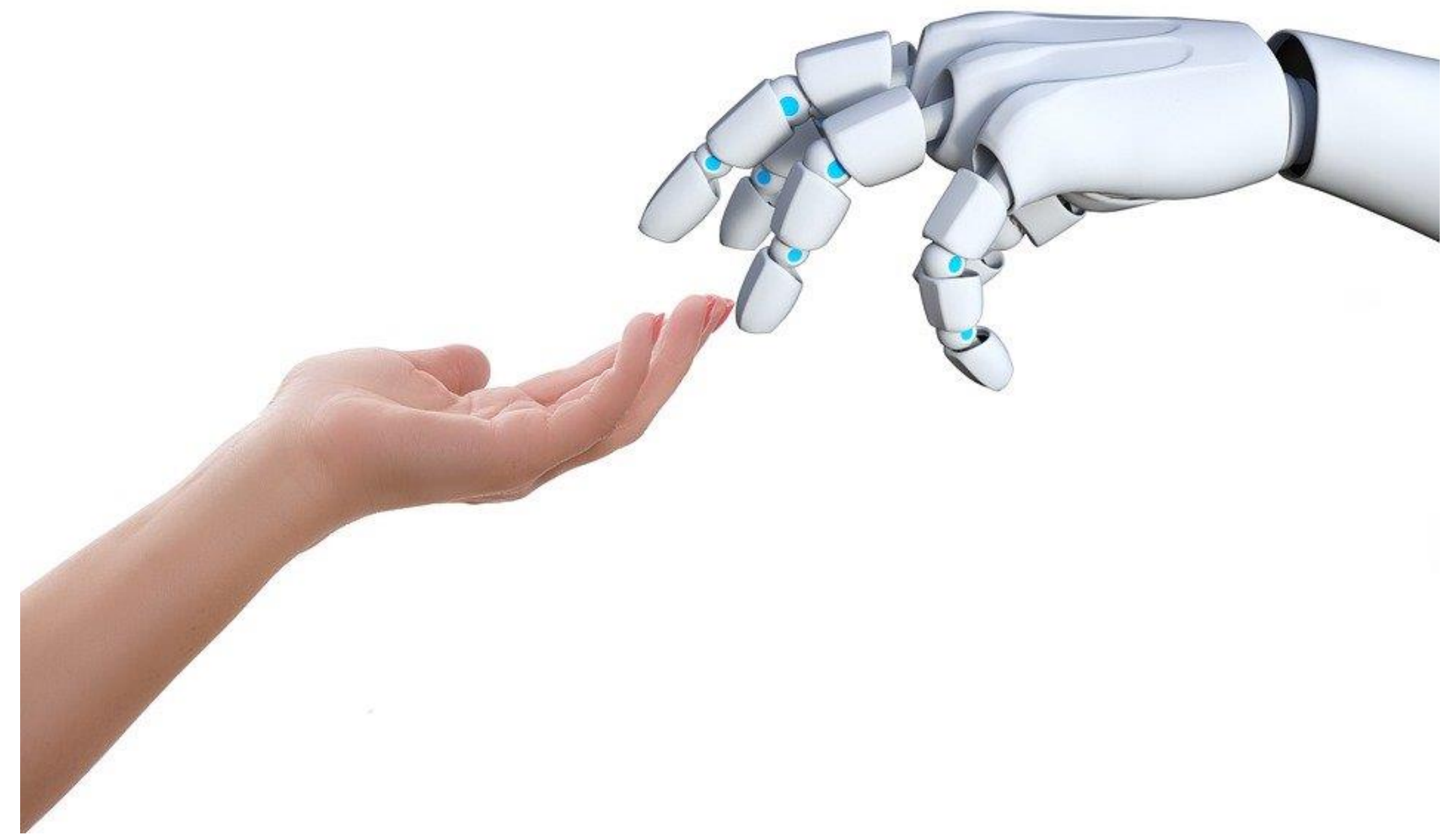
- 1st – **steam engines** replace human labor;
- 2nd - **electricity** replaces steam engines;
- 3rd - **automation**, i.e. computers appear, that follow specific instructions;
- 4th – **autonomy**, i.e. machines plan and learn.

CONTENT 6

History – transition to autonomy

Example – industrial robots:

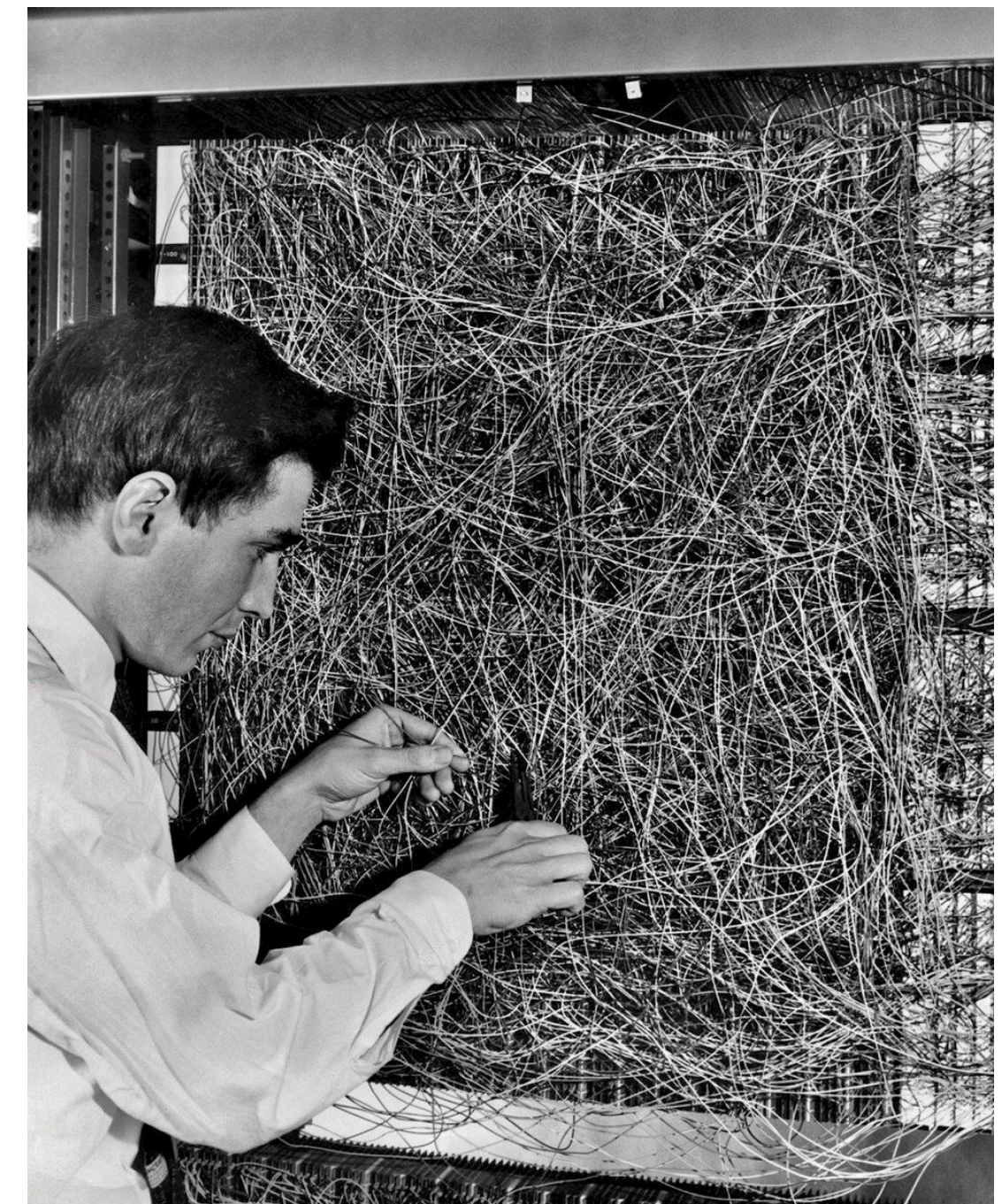
- 1st stage, automation – a hand moves and grabs objects by pre-set coordinates;
- 2nd stage, autonomy - a camera that sees the object and has an end goal without prior step-by-step instructions.



CONTENT 6

1st Stage in the development of ICS

- The 50s of the XX century;
- Target - **building sensible machines that mimic the human brain.**
- Representative – the self-organizing machine **PERCEPTRON** (perceptual device) by the psychologist F. Rosenblatt. This machine, as a rough model of the retina of the human eye, had to be trained to recognize visual images.



CONTENT 6

1st Stage in the development of ICS - results

Similar to human vision, the input/"retina" of the device is an ordered plurality of n binary elements

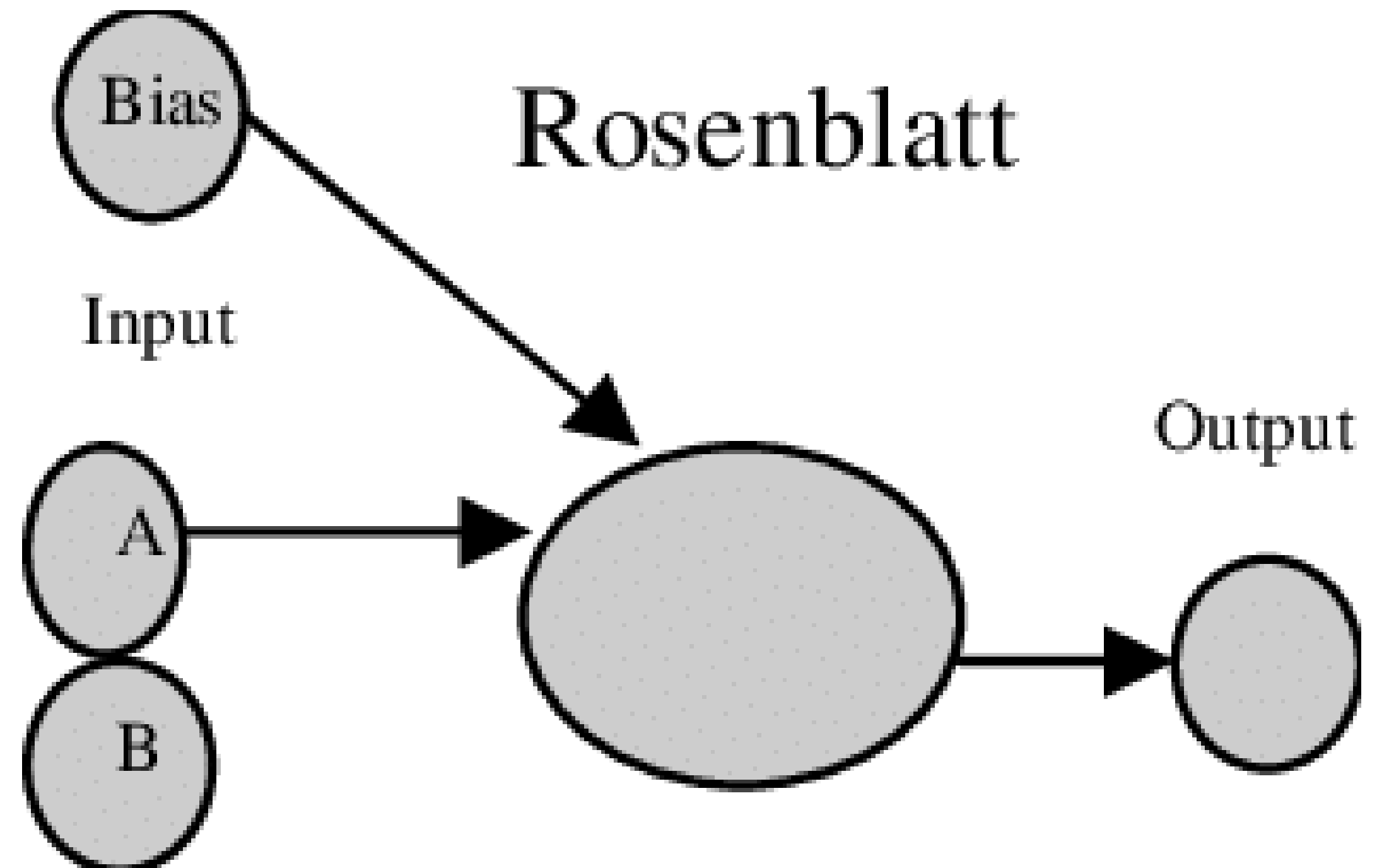
$$R = (X_1, X_2, \dots, X_n)$$

One image is the sum of the values of the elements of R, for example:

$$R = (1, 0, 0, 1, \dots, 1), X_i \in \{0, 1\}$$

If the retina has n variables, then 2ⁿ situations are possible.

- **Conclusion** – The apparatus and program tools prove to be inappropriate for the realization of such an idea, which has not been experimentally confirmed anyway.



CONTENT 6

2nd Stage in the development of ICS

- The 60s of the XX century.
- Target – **Resolver of any predefined tasks.**
- Representative – the system **GPS (General Problem Solver)**, created in **1959** by A. Newell and H. Simon.



CONTENT 6

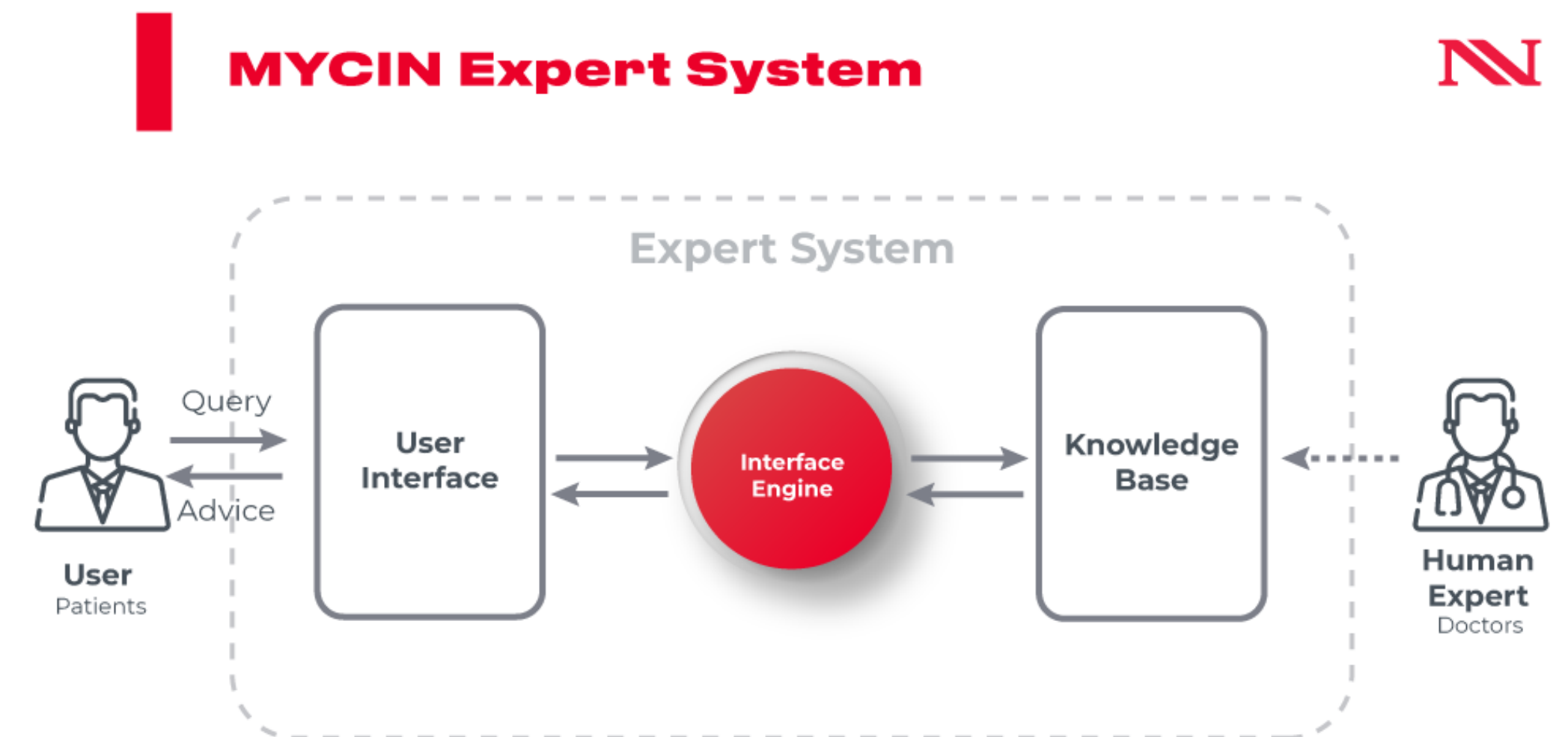
2nd Stage in the development of ICS - results

- Characteristic - **heuristic search**.
- The conceptual basis of GPS - the combination of computer science and psychology. According to A. Newell and H. Simon, the solution to each task is to search in the space of possible heuristic rules that help direct the search to the desired goal. In this sense, GPS is defined as an universal system, since each user can set the problem environment in terms of the objects and the operators that apply to them. This “universality” is applicable to a limited number of mathematical problems with a small number of states and well formulated rules.
- **Conclusion** - GPS and its modern similarities function for formalized tasks, such as “The Tower of Hanoi”, which are without particular practical value, but remain a classical program of AI.

CONTENT 6

3rd Stage in the development of ICS

- The 70s of the XX century.
- Target – **expert system**. Efforts are directed not towards the search for universal heuristics, but towards what every specialist expert has - skills, practices and informal rules.
- Representative - **DENDRAL** and **MYCIN** for the diagnosis of bacterial infections of the blood;



CONTENT 6

3rd Stage in the development of ICS - results

1. Knowledge is set by rules

IF (1) the infection is a primary bacterial, AND

(2) the place, from which the sample is taken is sterile, AND

(3) it is supposed, that this organism has entered through the gastrointestinal tract,

THEN it can be assumed (0,7), that this organism is of bacterial character.

2. The system is robust - the rules have confidence factors that allow incredible data and inaccurate information to lead to credible conclusions.

3. The system itself can explain the reflection process.

- **Conclusion** - MYCIN, despite its limited capabilities, is workable and useful in practice.

CONTENT 6

4th Stage in the development of ICS

- The 80s and 90s of the XX century.
- Target – **training and self-educating of ICS.**
- Representative – the machine-learning system **EURISKO**. It itself improves and expands its heuristic rules, and the language for descriptions of rules and concepts allows "meta-rules" in it as a "self-consciousness" in rudimentary form. It also manages its own behavior by remembering the rules it found and applying them to itself. It has won a war game three years in a row (with the rules of the game being changed every time) and it designed a completely new, 3D integrated circuit of the type AND/OR with an ultra-high degree of integration.

CONTENT 6

4th Stage in the development of ICS - results

- **Types of learning:**
 - by remembering situations;
 - through analogues;
 - through discoveries;
 - through search guidance;
 - through generalizations, etc.
- **Conclusion** – This type of IS find wide practical application.

CONTENT 7

ICS popularity

- Devices in which we can integrate a microprocessor and memory are potential intelligent systems.
- The development of information technologies is a prerequisite for the wide integration of ICS in all aspects of life.

CONTENT 7

ICS application

- cars;
- robots;
- CNC machines;
- online stores;
- systems for traffic management;
- terminals for sales of goods;
- ...in almost all of the industries in the world.

CONTENT 7

Scenarios for future development

- **Scenario 1:** a stage of rapid progress and reaching the human level in the performance of many tasks.

- **Scenario 2:** stage of slowdown of progress due to:
 - the large amount of data that will have to be processed;
 - critical attitude in people;
 - the introduction of regulations.

CONTENT 7

ICS problematics

- Search for a solution (in the state space);
- Action planning;
- Communicating with the computer in a language, close to the natural;
- Visual image recognition;
- Knowledge representation;
- Expert systems;
- Neural networks.

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