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**Use of Artificial Intelligence
in Intellectual Property:
From Mathematical Origins
to Practical and Philosophical-
Legal Aspects**

Baku – 2025

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Use of Artificial Intelligence in Intellectual Property: From Mathematical Origins to Practical and Philosophical-Legal Aspects. Baku, 2025

This book has been prepared based on the opening remarks and the presentation titled “Use of Artificial Intelligence in Intellectual Property: From Mathematical Origins to Practical and Philosophical-Legal Aspects” delivered by Kamran Imanov, Chairman of the Board of the Intellectual Property Agency of the Republic of Azerbaijan, at the international conference “Intellectual Property and Artificial Intelligence”, which was organized jointly by the Intellectual Property Agency and the World Intellectual Property Organization (WIPO), on 9–10 December 2025.

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INTRODUCTION

Dear friends,

The conference concerns the use of artificial intelligence in the field of intellectual property, patents, and first of all, I would like to speak about the historical significance and impact of artificial intelligence, beginning from its fundamental roots. I note that artificial intelligence is a special phenomenon — one of the most remarkable inventions of human civilization. Despite its immense, even revolutionary impact, this **phenomenon** is not assessed unambiguously for certain reasons. Although AI's influence is undoubtedly vast, its use is met with a certain degree of caution in professional circles and society from an ethical and legal perspective.

I do not agree with such views, shared by many scholars and professionals, for one important reason. Drawing on Murphy's famous humorous "law," it follows that every solution to a problem, any decision made, generates new problems — and naturally, resolving them becomes the responsibility of the decision-makers and those who support them. Therefore, it is impossible to restrain the development of AI. Intellectual property should not serve as a barrier to new technologies, but instead must adapt to them.

In Azerbaijan, AI-related issues have always been in the spotlight. The “Artificial Intelligence Strategy of the Republic of Azerbaijan for 2025–2028,” signed by **President Ilham Aliyev**, has been approved. This important document covers areas such as the economy, public administration, education, infrastructure, and more. The Strategy includes instructions on improving the regulatory framework, adopting the “Law on Artificial Intelligence,” which embraces data ethics and responsibility issues, and establishing an AI Academy — naturally bringing amendments to IP legislation onto the agenda.

Distinguished participants,

1. The creation of artificial intelligence has always been a desire of human society. A look at the past of AI from ancient times to the present shows that its historical retrospection reflects the stages of human efforts aimed at creating intelligence outside the human being.

This history, with its mythological origins, dates back to antiquity up to the 17th century and provides us with representations of “intelligent” mechanisms. Automaton-warrior Talos, Hephaestus who created mechanical assistants, and Pygmalion are vividly depicted in Ancient Greek myths.

In the Middle Ages, the Golem appeared as a symbol of artificial creation, while great thinkers of the past began

discussing the nature of the mind and, most importantly, the possibility of formalizing it.

Although remarkable thinkers such as Philo of Byzantium, who created a mechanical servant, or Leonardo da Vinci with his mechanical lion and knight, produced precursors of “intelligent” machines, their uniqueness and lack of AI foundations meant that no legal problems arose.

In the 18th–19th centuries, “intelligent” machines like Wolfgang von Kempelen’s “mechanical chess players” emerged.

The development of algebra and computation theory became a special impetus for the creation of AI.

It was the advancement of logic and mathematics that laid the foundation for the description of intelligence through formal rules, leading in the 20th century to the concept of computers and artificial intelligence. In 1943, McCulloch and Pitts created the artificial neuron model, and with this, the foundation of neural networks was laid. In 1950, Turing established criteria for “intelligent” machines; and finally, at the 1956 Dartmouth Conference, the term “artificial intelligence” appeared, opening the path for its broad application, and this meant the emergence of artificial intelligence as a scientific discipline.

In our era, from 1956 to 1970, the first programs capable of playing chess, proving mathematical theorems, solving logical problems, and manipulating knowledge and rules were created through symbolic AI. During this period, Lotfi Zadeh introduced fuzzy sets, fuzzy logic, and approximate reasoning.

However, the limitations of knowledge and computational power at the time, and the inability to solve fundamental problems, led to skepticism and disappointment. For this reason, the years 1970–1990 are called the “AI winters.”

Nevertheless, the rapid rise of the Internet, the expansion of data volumes, the development of neural networks, and the emergence of SVM, Random Forest, and other algorithms brought about a revolution in machine learning in the 1990s–2010s. After 2012, with AlexNet’s breakthrough on ImageNet, AI entered the deep learning era. Recurrent and convolutional networks, speech and image models, and new-generation chatbots appeared.

Neural networks and fuzzy logic began to hybridize.

Since 2017, a special, distinct era began — the era of language models and generative AI. Transformer architectures, GPT (OpenAI), BERT, and other innovations became landmark achievements enabled by AI.

Today, artificial intelligence is not merely a tool — it is an infrastructure integrated into the economy, culture, and governance.

What is the significance of AI in the world around us? What role does it play in the economy and socio-cultural sphere?

Economically, AI is a driver of growth. (According to McKinsey and PwC, AI may add 15–20 trillion USD to the global economy by 2030.) Today, AI is creating new industries and business models in robotics, autonomous vehicles, bioinformatics, financial and insurance technologies, personalized medicine, and other areas.

AI optimizes state processes through “smart governance” (digital public services, anti-corruption measures, smart cities and villages — Azerbaijan is a notable example). Thus, **AI is one of the main forces of digital sovereignty.**

Socially, AI fundamentally transforms the labor market, replacing obsolete professions with new high-skilled jobs. This does not mean that humans will compete with AI; the future principle is cooperation between humans and AI. AI also gives rise to new communication and media forms — generative AI is transforming journalism and shaping new content formats. Finally, AI enhances social inclusion by providing access to automatic

translation, speech and face recognition, and assistive technologies, supporting people with disabilities.

Culturally, AI profoundly changes the notion of **creativity**, becoming a co-author in creative processes and expanding human imagination in fields such as architecture, cultural memory, archives, design, music, and cinema. With AI, humanity is entering an era of hybrid creativity where the boundary between human and machine gradually fades.

AI also raises fundamental questions about human identity and values: *What does it mean to be human? Who is the author? Where are the limits of automated intelligence? How can cultural heritage be preserved in the age of digital replication?*

Finally, AI plays a significant role in cultural diplomacy and international cooperation, becoming a soft-power tool and an object of global regulation by UNESCO, OECD, WIPO, and the EU's AI Act. **Thus, the history of AI is not only an evolution from mythological ideas of mechanical intelligence to transformers and generative models; it is also the story of becoming a pillar of the global economy and a leading factor of socio-cultural transformation.**

Overall, the impact of AI can be compared to the invention of electricity, the emergence of the internet, and even humanity's invention of writing.

2. When we speak of artificial intelligence, we imply its ability to engage in a certain level of intellectual activity (IA). This means recognizing, from a legal standpoint, the results of intellectual activity (RIA) created with AI involvement — whether autonomously or semi-autonomously.

Leaving aside for a moment the question of ownership of these RIA, let us focus on the knowledge embedded in them — accessible, transformed, and turned into new knowledge. **This approach is based on the uniqueness of human thinking, logic, and imagination.**

Modern AI systems rely on two major achievements of mathematics, cybernetics, and control theory — fuzzy logic and neural networks. The synthesis of these two approaches created neuro-fuzzy systems (NFS), known as hybrid systems.

Traditional computers operate on the von Neumann architecture and execute explicitly formulated sequential instructions. NFS, on the other hand, consist of highly parallel processing blocks capable of recognizing patterns in input data and executing commands not explicitly programmed. Fuzzy logic, unlike traditional approaches, relies not on precise measurements but on assessing to what degree an object belongs to overlapping sets — exhibiting approximate reasoning.

As a result, NFS are largely adaptive systems — capable of changing their structure based on internal or external information passing through the network. Instead of mathematical calculation of numbers, such systems model complex relationships between input and output or identify patterns in data.

The fundamental advantage of NFS is that they combine two contradictory requirements of fuzzy modeling: **interpretability and accuracy**. They create a synergistic effect by merging the human-like reasoning of fuzzy systems with the connectionist structure of neural networks.

Thus, **universal approximators capable of producing interpretable “if..., then...” rules** can, under certain essential criteria, be considered as potential analogues to human-created RIA close to generating new knowledge — and such systems are precisely NFS.

Dear friends,

3. The central advantage of AI lies in its structure and decision-making, which imitate human principles. In other words, the value of AI is found in its **anthropological nature** — its reliance on approximate human-like intelligence and its ability to imitate cognitive functions such as thinking, reasoning, and problem-solving. Though still limited, these capabilities are expected to grow. These sensitive aspects of AI—its mimicry of human cognition—

drive global discourse to maintain an anthropocentric legal approach: **only the human being is recognized as the creator (author or inventor).**

Over the last 30–40 years, scientific and public understanding of AI has evolved along with the technological progress of AI systems themselves. Drawing from my personal experience, I can say that in the late 1970s and early 1980s, while serving as Director of the Scientific-Research Computing Center under the Ministry of Higher and Secondary Education, I lectured mathematicians on fuzzy systems, fuzzy logic, and neural networks — and each scientific advancement was inspiring, uplifting, and did not trigger philosophical-legal debates. The question “Will AI and information technologies replace humans?” belonged solely to the realm of science fiction.

Today, in current discourse, we see two intertwined issues:

First issue: Can AI create RIA comparable to human-created works, replacing or even surpassing the thinking of the human creator? Answer: **No.** We believe AI will not, in the foreseeable future, be able to address questions related to perception (including emotional perception) and consciousness. Current forms of logical inference and underlying logic do not yet allow for this.

Second issue: Is it possible to register applications submitted by generative AI directly *in the name of the AI system*?

In principle, the answer could be “yes.” Here a new question arises: *Who* or *what* would be the rights-holder, and why should “electronic persons” not be recognized as rights-holders by analogy with legal persons?

When comparing natural persons and legal entities, we see that legal persons cannot be authors (inventors) and do not possess personal non-property rights. That is the difference. But the similarity is that legal entities can be rights-holders and own exclusive rights. For natural persons, the basis is creation, inheritance, contract; for legal entities — work-for-hire, succession, and contract. WIPO has a great deal of work ahead, as improving private law — first and foremost intellectual property law — requires collective effort.

I believe some valid arguments regarding the first issue are artificially transferred into arguments about the second.

We have repeatedly stated that new IP objects, new methods of use, and new application domains have emerged — driven by high technologies in the life sciences and by AI. For example, large-scale datasets produced in biological sciences no longer fit into the traditional IP

framework. Likewise, for AI-generated commercial music, works, or inventions — whether created with or without human involvement — concepts like “composer,” “author,” and “inventor” remain unclear. This is why more and more reliance is placed on the institution of **trade secrets** for protecting big data.

These contradictions affect numerous issues of private international law. Questions arise regarding ownership of (traditional) **databases** and the rights associated with AI. We agree with experts who state that **“for objects that exceed traditional IP categories and do not fit classical IP rights, a reconsideration of property rights concepts seems inevitable.”**

Can the legal protection of AI-generated RIA be applied under the traditional work-for-hire doctrine? To what extent is it justified to recognize rights as a result of human activity regardless of the degree of creative contribution?

As for recognizing objects created without human involvement as IP objects — and more importantly, as legal subjects (including the possibility of subjectlessness) — debates continue, and sooner or later a decision will be reached.

Despite all this, as AI expert Dario Amodè (author of *Machines of Loving Grace*), listed among TIME magazine’s 100 most influential people, notes, by 2026 AI may

become “smarter than Nobel Prize Laureates” in all major fields and process information 10–100 times faster than humans. According to OpenAI’s CEO Sam Altman, the “rise of AI intelligence” will occur in only a few thousand days (around 2027), as neural network power grows exponentially. AI Multiple reports that the computational power of the largest IP models doubles every 7 months.

I do not wish to sound skeptical, but it must be noted that the largest neural networks today have about 2 trillion parameters, while the human brain has roughly 100 trillion, 50 times more. This means that AI’s “intelligence rise” is unlikely before 2040–2050. Thus, AI has a long way to go before overtaking humans in speed and memory capacity. On the other hand, automobiles are faster than humans, yet we do not compete with cars — we simply use them as a convenient tool.

Still, the accumulated problems must be solved, and we hope for WIPO’s support. We must not avoid problems, because according to Murphy’s law, every solution creates new problems.

Distinguished conference participants, dear friends,

4. Now allow me to present global and Azerbaijani statistics on intellectual property (specifically patents), as I planned.

In 2024, the number of patent applications worldwide increased by 4.9% compared with 2023

(reaching 3.7 million). In the IT sector, growth was 13.2%. Industrial design applications increased by 2.2% (1.6 million), while the decline in trademarks has stabilized.

In Azerbaijan, as of December 2025 (compared to 2024), applications for industrial property rights increased by 42% (378 vs. 267). This includes a 41% increase in inventions, 9% in utility models, and 132% in industrial designs. Regarding international patents: PCT filings increased by 33%, Eurasian filings by 66.7%, and Hague industrial design filings by 146%. In the GII-25, Azerbaijan's patent system is listed among the country's strengths (53rd–57th places), while utility models rank 38th.

All these increases are the result of President Ilham Aliyev's innovation-oriented institutional reforms and the effective operation of the PENAH system, the open register, the call center, numerous meetings with potential inventors, and the development of methodological documents. Additionally, the establishment of IP departments and branches at Baku State University, Azerbaijan University of Architecture and Construction, and ASOA has contributed to the formation, dissemination, and teaching of IP culture.

We are pleased to note that, among 204 intellectual property offices worldwide, our structure and performance have been ranked among the selected 15th, and this achievement was reflected in the book titled

“Future-Oriented Leaders,” published in 2025 based on a survey conducted by WIPO. Furthermore, the prestigious journal *Intellectual Property: Industrial Property* published an extensive article on our Agency titled “Formation and Functioning of a Modern IP Office.”

In November of this year, Azerbaijan’s IP policy was presented as an example at the Russian Presidential Academy of National Economy and Public Administration, where President of the Eurasian Patent Organization, Mr. Grigory Ivliev, recommended applying the Azerbaijani experience in Russia.

I express my gratitude to Ms. Ulrike Till and Mr. Grigory Ivliev for their kind support.

Finally, returning to our main topic — AI — I would like to offer an example from Azerbaijani folklore. As you know, Azerbaijani folklore (traditional cultural expressions) has been protected by law as a special type of intellectual property since 2003. The protection of traditional knowledge, along with folklore examples, is part of the public domain. They are registered by the Agency and certificates are issued within the framework of safeguarded protection. The wisdom of our people, reflected in our folklore, allows us to present the following example: in relation to AI, “we must be masters of our will and servants of our conscience”!

Thank you!

Use of Artificial Intelligence in Intellectual Property: From Mathematical Origins to Practical and Philosophical-Legal Aspects

INTRODUCTION

Artificial intelligence (AI) is a unique phenomenon, whose significance can be compared to the discovery of electricity, the Internet, and even writing in the evolution of human civilization.

When we speak about artificial intelligence, it is assumed that AI is capable of reaching a certain level of intellectual activity (IA). This, in turn, implies the possibility of recognizing the results of intellectual activity (RIA) created with the involvement of AI—either non-autonomously or autonomously generated by it.

Setting aside for now the questions of who specifically holds rights over such RIAs, which form the basis of protectable intellectual property objects, we will focus on the knowledge that is accessible to and used by AI in creating these RIAs, and which is then transformed into new knowledge. The foundation of this approach lies in the ability of AI to imitate—within the limits available to it—the human process of generating RIAs by embedding

in AI certain elements of logic, thinking, and even imagination, which are unique natural and genetic human resources.

Modern AI relies on two outstanding achievements of mathematics, cybernetics, and control theory—fuzzy logic and neural networks. Their hybridization has enabled the creation of neuro-fuzzy systems (NFS). As is well known, traditional computers are built on a von Neumann architecture and are therefore capable of sequentially processing and executing explicitly defined commands. NFS, however, have a different architecture consisting of elementary processing units with a high degree of parallelism, integrated into a network-system. An NFS can execute implicit commands based on recognizing patterns within the input data.

Just as fuzzy logic transforms traditional views—replacing exact measurements with fuzzy information that indicates the degree of membership in ambiguously defined, overlapping sets—most NFS function as adaptive systems. They change their internal structure under the influence of external or internal information that passes through the network. Instead of calculating numerical outputs from numerical inputs, NFS model complex relationships between inputs and outputs or identify patterns within data.

The principal advantage of NFS lies in their ability to reconcile two seemingly contradictory requirements of fuzzy modeling: interpretability and accuracy. NFS produce a synergistic combination of these achievements, because they unite the human-like reasoning style of fuzzy systems with the learning capabilities of the connectionist structure of neural networks. In other words, they are universal approximators endowed with the ability to formulate interpretable “IF–THEN” rules. Here we are speaking of analogies—accessible models that can to some degree (!) approximate human-generated intellectual activity (IA), which is capable of producing new knowledge and, when the necessary legal requirements (criteria) are met, can be classified as intellectual property (IP).

NFS embody precisely this potential. The first three parts of this study are dedicated to these questions. The final part discusses legal, philosophical, and other issues related to the development of AI.

According to the author’s approach, the chosen structure of presentation is convenient for examining the problems centered on AI for several reasons. First of all, AI is called “intelligence” precisely because it is capable of intellectual activity (IA), and as a result, it can produce results of intellectual activity (RIA). Therefore, the study begins with an analysis of RIA: the relationship between

“information–knowledge” from the standpoint of IP, the scope and content of the concept of RIA, and a representation of the knowledge cycle from an IP perspective. It also explores the interaction and correlation between the components of RIA—namely “knowledge” and “information”—their differences, the processes of subjectivizing information and objectivizing knowledge, and the circulation of knowledge through the medium of information. In this way, the object of “modeling”—that is, the imitation carried out by AI by analogy with human cognition—is identified.

In brief, this section may be described as: **“What is being modeled?”**

The next section proceeds from the use of AI in the field of IP; therefore, AI is examined from a systems-cybernetic perspective. It provides the necessary introductory information from mathematical logic and computation theory, including Boolean algebra operations, the rule of logical inference (*modus ponens*), implications and their transition to fuzzy analogues and approximate reasoning, including the compositional rule of inference and various logics describing the fuzzy “input–output” relationship, which play a fundamentally important role in forming RIA. The section also discusses the biological neuron and its model—the “artificial neuron,” neural networks, and their hybridization with

fuzzy logic in the form of the fuzzy neuron and the fuzzy neural network. In brief, this section—describing the formal tools of modeling—can be summarized as:

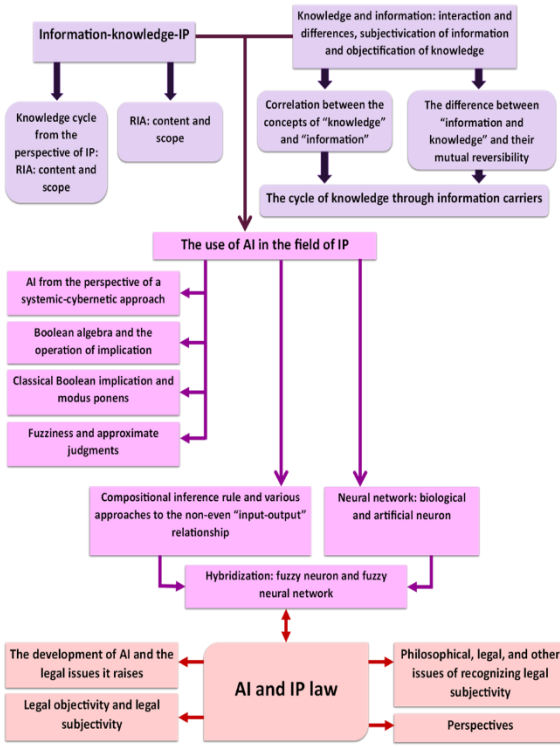
“How is modeling carried out?”

The concluding part examines the issue of AI and IP law, analyzing philosophical-legal and ethical questions related to recognizing the legal objecthood and legal subjectivity of RIAs created with or without human participation, including generative RIAs. Autonomous and non-autonomous AI systems are considered, along with comparisons between autonomous IP systems and generative ones. The study presents international experience and statistics relating to the recognition of AI-generated objects in various major jurisdictions and international institutions. It also analyzes potential ways to recognize RIAs created without human involvement in the context of AI development.

In brief, this section may be formulated as:
“For what purpose (toward what end) is modeling carried out?”

A plan-scenario of the presentation and a concise diagram of the material are attached.

Plan–Scenario of the Presentation

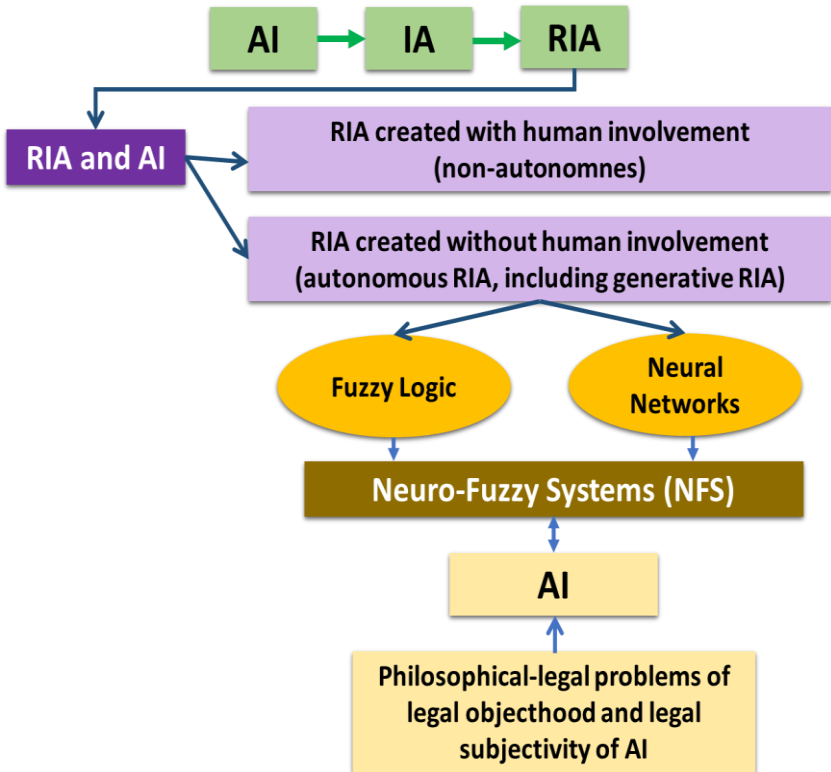


The subject of modeling: generated in the cognitive process thanks to the subject's thinking [**What** is the subject of models?]

Formal modeling tools: the cognitive process and thinking of the subject [**How** is modeling carried out?]

Philosophical, legal, and ethical issues of AI models [**Why** is modeling carried out?]

Brief Outline of the Presented Material



I. “INFORMATION – KNOWLEDGE – INTELLECTUAL PROPERTY”

1. Circulation of Knowledge from the Standpoint of Intellectual Property (IP)

The foundation of all new knowledge—and thus all accumulated knowledge—is human imagination, which, in the view of the great Einstein, is even more important than knowledge itself. Indeed, the history of humanity is the history of applying imagination—creativity and innovation—to the existing corpus of knowledge. It is imagination that fuels progress in both science and art, imagination that enriches our knowledge as a source of individual, cultural, and economic advancement. To imagination we owe the reality in which we live today.

It is perhaps for this reason that our ancestors expressed in their ancient, timeless literary monument *Kutadgu Bilig* the idea that “**intellect brings happiness.**”

Emphasizing the special significance of intellect and knowledge, the eminent philosopher of the 20th century Karl Popper offered a remarkable example demonstrating how much more fundamental and valuable they are than any material object.

Popper suggested imagining a situation in which our entire economy—industrial and social structures—had been destroyed or disappeared, while scientific and cultural knowledge remained intact. In this case, he wrote, humanity, relying on intellect and the preserved knowledge, would be able in a short time to restore the lost material and social world. Conversely, if all accumulated knowledge were to disappear while the material world remained, the picture would resemble an abandoned industrial civilization now inhabited by primitive tribes.

Intellectual property is closely linked to knowledge: it is formed from existing knowledge and itself becomes a source of new knowledge. More precisely, intellectual property simultaneously acts as both the **raw material** and the **product** of the “circulation of knowledge.” The “circulation of knowledge” is essentially a process whose core element is the intellectual activity of a human being. Since the results of this activity are products of the mind—intangible, imperceptible, ephemeral, or ideal in nature—they are immaterial.

To own immaterial property means to possess *rights* to it. Intellectual property rights (IPR), because the Results of Intellectual Activity (RIA) possess a “replication effect,” must be exclusive. Only the rights holder may make decisions concerning his or her intellectual property (IP).

It is equally important that **RIA are a form of information**, although the reverse is not always true. The term “information” may be understood in different senses— as a means, a process, or documented data. Information does not necessarily appear as an ideal, intangible, non-consumable good; being identified with its carrier, it may take the form of information resources, document collections, and so on. For this reason, in order to avoid ambiguity, one may, in a certain approximation, equate RIA with the term “**knowledge**”, understanding it as a substance existing in the consciousness of the individual who created the RIA—knowledge that has no meaning outside the subject.

Knowledge within the subject’s consciousness is formed and accumulated from available knowledge through the process of cognition; through creative and intellectual activity, it may be transformed into new knowledge. When new knowledge becomes objectified—in other words, when an RIA receives objective expression—it undergoes a transition from an immaterial good into a material one, and intellectual property arises.

Thus, by protecting intangible assets such as knowledge and information, intellectual property safeguards the creative capacities and innovations that are recognized as universal natural resources.

A right to an RIA emerges during the objectification or transformation of knowledge—initially subjective and belonging exclusively to the individual—into something objective, transferable to a material medium. In this process, knowledge (i.e., the RIA) becomes “materialized,” becomes perceivable, and thereby turns into an object of IP. For this reason, the knowledge and information contained in an IP object must have an objective form of expression; through this objectification, the IP object becomes an informational product, acquires economic value, and becomes a specific type of commodity.

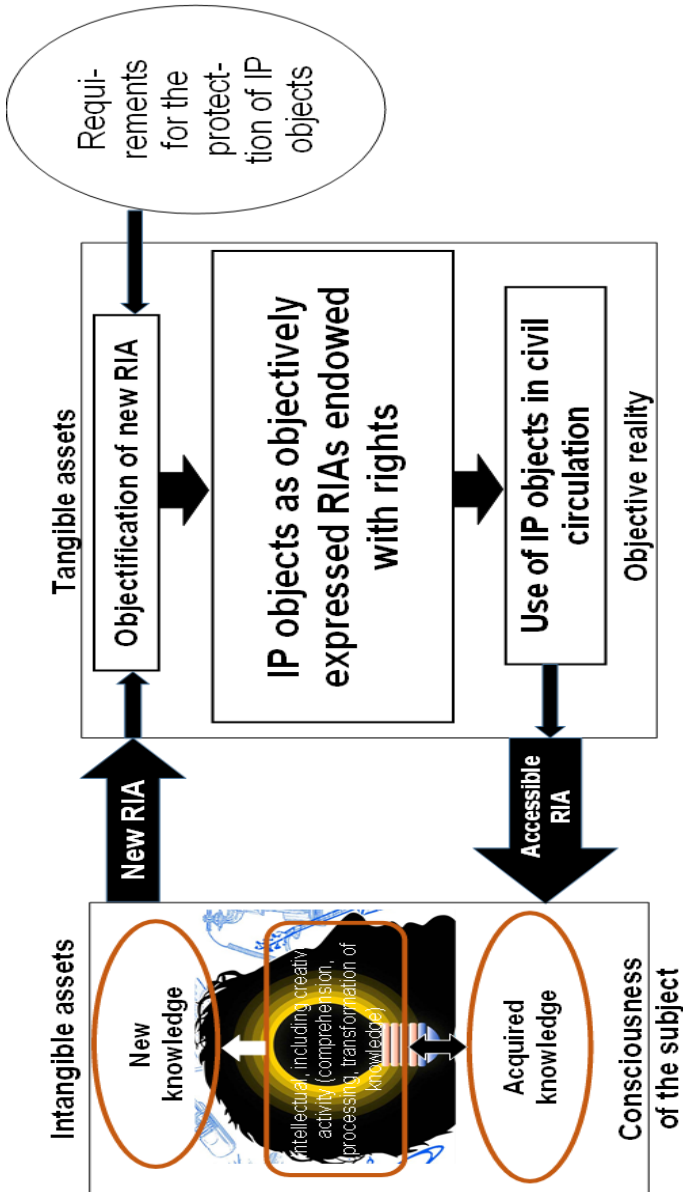
Once this occurs, IP objects can be used economically—that is, introduced into commercial circulation. Indeed, the desire to access the content of necessary informational products as quickly as possible, to utilize the knowledge and information contained in a given IP object, is satisfied through information technologies that accelerate their acquisition and processing. This desire reflects the market actor’s motivation to outpace competitors—to learn earlier and to capitalize on available opportunities for business advantage.

Therefore, even from these general considerations, we can see that there is an inherent relationship between information and information technologies, knowledge and intellectual property, and economic circulation.

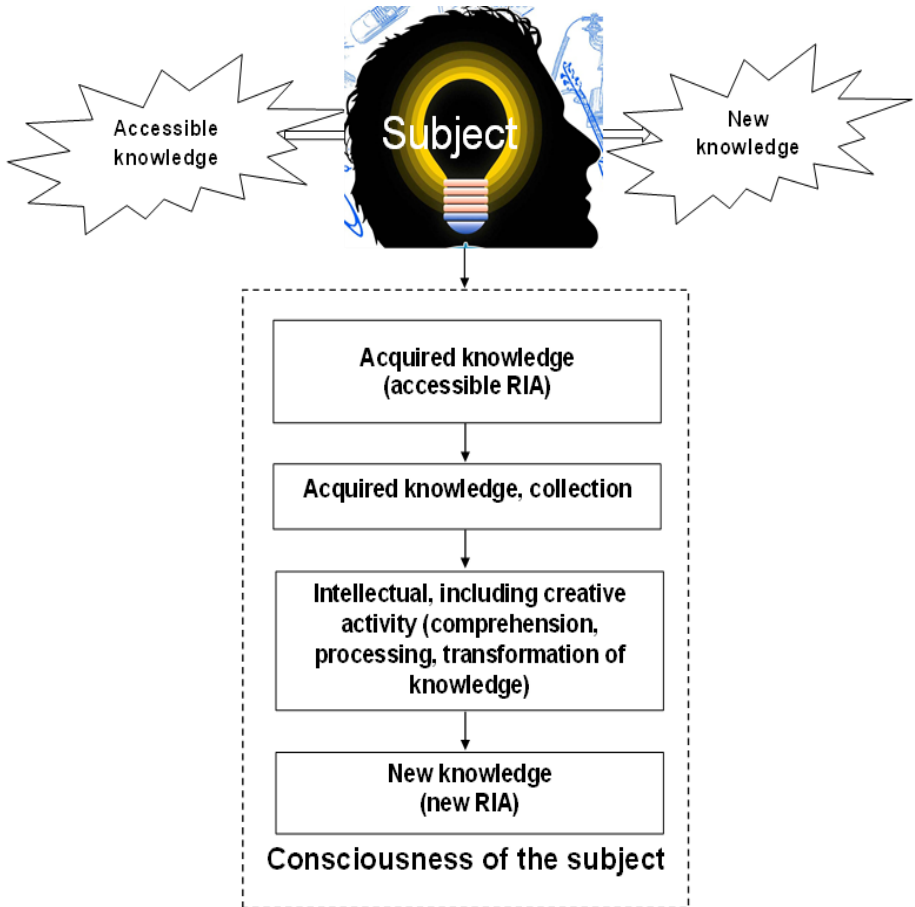
Below are two figures:

1. The first illustrates the circulation of knowledge from the standpoint of IP;
2. The second depicts knowledge as both the “raw material” and the product of intellectual activity in the consciousness of the subject.

Circulation of Knowledge from the Standpoint of IP



Knowledge as the “Raw Material” and Product of Intellectual Activity



It should be noted that in economic theory, among the various economic resources that generate goods—such as natural resources, labor, capital, and entrepreneurship—**knowledge (the intellectual resource)** is also included.

The specificity of knowledge as an intellectual resource, or as a result of human intellectual activity (RIA), lies in its particular properties. Let us highlight these properties.



First, knowledge as a resource is intangible; that is, it has an ideal nature (and becomes an IP object because of the dual nature of the latter).

Second, unlike natural resources, knowledge does not physically depreciate, although over time it may become morally obsolete as newer and more advanced technologies emerge. In essence, knowledge is a *non-exhaustible resource*, expanding faster and improving as it is productively consumed.

Third, knowledge has unlimited utility and may be used simultaneously by several users at once, generating a synergistic effect through knowledge exchange and thereby an effect of economies of scale.

As a consequence—commenting on the third property of knowledge—it provides a company with a significant advantage **only if** its counterparties or competitors do not have open access to that knowledge. Unlike material resources, intellectual resources (knowledge) do not possess the property of scarcity and, in this context, inaccessibility. They become vulnerable as soon as they become known to a broad circle of people, and once the novelty becomes known, any company may employ it in its production. It is precisely the task of the intellectual property (IP) system—by introducing exclusive rights to RIA—to ensure the *inaccessibility* of RIA to competitors, thereby imparting to knowledge the property of scarcity and, from the standpoint of property relations, creating a monopoly over the use of the IP object.

The existence of a legally established monopoly creates conditions for the dissemination of protectable knowledge also in commodity form.

Thus, the intangible nature of knowledge and the presence of a monopoly over it create the very phenomenon of intellectual property.

Accordingly:

First, in order for an RIA to become an IP object, it must possess one mandatory feature — it must be expressed in an objective form. Therefore:

objectively expressed RIA = intellectual property.

Second, the participation of intellectual property in economic circulation as an intellectual product, and its status as a commodity, means that legal regulation and legal intervention are possible only at the stage of using objectively expressed RIA. Thus:

IP = intellectual property = objectively expressed RIA.

Third, rights to an objectively expressed RIA or intellectual property rights ensure the belonging of this type of property to its holder, and being exclusive, they guarantee the right holder's authority to dispose of the intellectual property object.

Another important issue is the recognition of intellectual property rights. The reason for recognizing these rights is not only respect and appreciation for creators and their activities. Society benefits from this activity, and the value and benefit society receives are recognized by the state, which leads to the recognition and protection of intellectual property rights.

Consequently, it is necessary to understand the role and significance of intellectual property in societal development, since an important legal principle operates here: **“the right of one person corresponds to the duty of**

another.” The rights granted to the creator impose corresponding obligations on others in the use of these rights.

By establishing the IP system, the state seeks to balance the interests of both parties—society and the creator—maintaining this equilibrium in the form of a **“social contract.”**

2. The Content and Scope of the Concept of RIA

Let us deepen our understanding of the phenomenon of RIA.

From the standpoint of philosophy, RIA represents any products of the spiritual and intellectual activity of a human being, embodied in a form accessible to perception and reproduction. In other words, RIA is not merely a legal object, but an expression of human creative and cognitive activity—one’s “objectified” thoughts.

Philosophically, it is a form of the **objectification of spirit** (in Hegelian terms: the transformation of an idea into objectivity), combining both the **ideal** (mental, spiritual content) and the **material** (text, diagram, program, device).

In its ontological status, RIA is dual in nature. RIA is always double:

- the idea itself is not protected and exists in consciousness as a possibility,
- whereas in its objectified form (text, formula, drawing), the idea becomes a “thing,” and it is precisely this form that is subject to legal and social recognition.

As a social phenomenon, RIA does not exist in a vacuum. The value of an RIA is determined by its

recognition by society and its potential usefulness. It is the philosophy of law that studies how society should regulate relations concerning the use of RIA in order to stimulate creativity while ensuring fair access to knowledge and culture.

RIA, by definition, also raises the issue of property: **Is an idea, a song, an invention, or an algorithm “property” in the same sense as a physical object?** Philosophy questions the very concept of intellectual property, because by nature it is non-exclusive—its use by one person does not hinder its use by another.

Thus, **RIA is a transitional category between subjective knowledge and an objective cultural artifact.**

In philosophical analysis, two characteristics are used:

Content of a concept — the set of its most essential features forming its distinctions and boundaries.

Scope of a concept — the set of all objects possessing those features.

Content and scope are mutually inverse:

- **the broader the scope, the narrower the content;**
- **the richer the content, the narrower the scope.**

If we compare the scope of RIA in philosophy and law:

Philosophically, the scope of “RIA” is broader and may include:

- scientific, artistic, technical works (from theories to paintings);
- organizational and social innovations (e.g., new modes of interaction);
- symbolic constructions (languages, sign systems).

In other words, any new form of knowledge, symbol, or technique that has found expression.

In law, the scope is narrower: only those results that can be formally separated from the subject and legally secured to the author or rights holder are recognized.

RIA as a Philosophical Category of “Protected RIA”.

The protection of RIA is a **secondary level**: not the product itself, but the system of its social recognition and institutional reinforcement. Philosophically, this is:

1. An act of institutionalizing knowledge.

Society recognizes the value of a result and protects its uniqueness.

2. An ontological paradox

We do not protect the “idea” itself but its expression, although the value often lies precisely in the idea.

3. A form of a social contract

Concerning the fair distribution of symbolic and material benefits arising from creativity.

Thus, “protection of RIA” is a mechanism that maintains balance between individual creation and collective use.

RIA may be analyzed in several philosophical contexts:

- **Gnoseological:** RIA as the result of cognition, the fixation of knowledge in form.
- **Ontological:** RIA as “the ideal within the material,” a synthesis of spirit and object.
- **Axiological:** the value of RIA as a bearer of truth, beauty, benefit.
- **Social-philosophical:** RIA as capital (symbolic, cultural, economic), requiring protection.
- **Legal-philosophical:** protection of RIA as institutionalized recognition of freedom and property in the realm of intellect.

Thus, from a philosophical standpoint, RIA is the objectification of individual or collective reason, transformed into a socially significant symbolic or technical artifact that exists at the boundary of the ideal and the material. And “protection of RIA” is a form of institutionalizing the value of these artifacts, ensuring their integration into the systems of culture, economy, and law.

Since the concept of “IP” operates with the terms “endowed (with rights)” and “protected (by rights),” we may outline their meanings:

If “endowment” and “protection” are synonyms for granting and safeguarding rights, then from a philosophical perspective their content and scope coincide with those of the concept “**intellectual property.**” These terms describe not the RIA themselves but the legal and ethical context of their existence in society.

Let us present a comparative scheme of RIA in philosophy and in law, clearly demonstrating the differences in their interpretation.

Criterion	Philosophical analysis	Legal Understanding
Ontological Status	Duality: ideal (the content of thought) + + material (the form of expression)	Only an objectified form, recorded in an explicit, verifiable form (text, drawing, program)
Scope	As broad as possible: everything that is a product of the mind (science, art, technology, symbolism, social forms)	Limited: only those results that can be identified, fixed, and protected (inventions, works, software, etc.)

Content	Objectification of the spirit, embodiment of knowledge, truth, beauty or utility	Specific protected objects listed in the law (patents, copyrights, trademarks, etc.)
Value	Cultural, spiritual, gnoseological, axiological	Economic, legal, property
Protection	Institutionalization of value: recognition by society and culture of the uniqueness of the result	Legal protection: legal norms establishing exclusive rights and sanctions for infringement
Social Role	The mechanism of transmission and consolidation of meaning, the formation of collective memory and culture	A means of regulating access and use, balancing the interests of the author and society

The above allows us to draw the main conclusion.

In philosophy, RIA is a broad category encompassing the full spectrum of spiritual and symbolic creativity, viewed as a bridge between consciousness and culture. In law, however, RIA is a narrowed subset—specifically

selected and formalized for purposes of protection and regulation.

At the same time, “protection of RIA” in the philosophical sense is the recognition of value, whereas in the legal sense it is an instrument for securing rights and economic interests.

A third column may be added — “Socio-Economic Perspective” — which will allow us to see how results of intellectual activity transition from the spheres of philosophy and law into the sphere of the economy and social relations.

Comparative Scheme: RIA in Philosophy, Law, and the Socio-Economic Perspective

Criterion	Philosophical analysis	Legal understanding	Socio-economic perspective
Ontological Status	ideal + + material, synthesis of spirit and thing	Fixed, identifiable form	RIA becomes a resource and an asset that turns into capital
Scope	As broad as possible any form of spiritual product	Limited list of protected objects	Only those RIA- s that can be commercialized or used in economic circulation

Content	Symbols, meanings, knowledge, creative forms	Objects defined by law (works, inventions, trademarks, etc.)	Technologies, brands, patents, and creative industry objects —things that have market value
Value	Spiritual, cultural, cognitive	Legal, property	Economic (profit, competitiveness) and social (reputation, symbolic capital)
Protection	Recognition of uniqueness by society and culture	Legal protection (exclusive rights, sanctions)	Monetization mechanisms: licensing, franchising, venture investment, government subsidies
Social Role	The formation of cultural memory and development of spirit	The balance of the interests of the author and society in law	Innovative development, the formation of a “knowledge economy,” and global competition

Thus, if **philosophy** reveals the deeper meaning of RIA as a form of the objectification of spirit, and law transforms it into a formalized category of a protectable object, then the **socio-economic perspective** turns it into **capital**—a resource that can be incorporated into economic circulation and the system of global competition.

A conceptual three-level model of the evolution of RIA in the philosophical, legal, and socio-economic dimensions (the path of RIA from idea to capital can be presented as follows):

[Level 1: Philosophical]

- RIA as the result of spiritual/intellectual activity
- Objectification of an idea into a form (text, image, drawing)
- Value: truth, beauty, utility



[Level 2: Legal]

- Legal recognition and protection of RIA
- Formalization into the category of a “legal object”
- Exclusive rights and protective norms
- Value: legal, proprietary



[Level 3: Socio-Economic]

- Transformation of RIA into an asset and capital
- Commercialization (patents, brands, licenses)
- Integration into the innovation economy
- Value: market-based, competitive, strategic

The logic of the transitions is also evident, namely:

- **Transition Spirit → Law**, when an individual idea receives societal recognition through legal norms;
- **Transition Law → Capital**, when a recognized object enters economic circulation and becomes a source of profit, power, and influence.

Let us also note that under the earlier interpretation—where IP was understood as *rights to RIA*—the term “intellectual property rights (IPR)” was essentially tautological, since IP itself was conceived as a bundle of rights.

However, if we interpret “**intellectual property as RIA or as protectable objects endowed with rights,**” then the term “*intellectual property rights*” acquires a clear justification and is no longer tautological.

II. “KNOWLEDGE” AND “INFORMATION”: INTERACTION AND DIFFERENCES, SUBJECTIVIZATION OF INFORMATION AND OBJECTIVIZATION OF KNOWLEDGE

1. Correlation of the Concepts “Knowledge” and “Information”

Let us note that earlier, when analyzing the circulation of knowledge in the emergence of IP, we used—and preferred—the term “*knowledge*” for clarity of exposition. This is because the categories “information” and “knowledge” are mutually convertible, as they are closely interconnected. Through human memory and the inherent capacities for thinking and imagination, *information* from the external world can be transformed into *knowledge*. In turn, *knowledge*, when transferred to a material carrier as a message and presented in the form of text, drawings, diagrams, etc., may itself become *information*.

The terms “information” and “knowledge” are used widely. There exist dozens of definitions of “information” in philosophy, biology, mathematics, physics, and communication technologies. In philosophy, “information” is an attribute of matter—a property of

reflecting diversity in any object or process of living and non-living nature. In biology, it is associated with living organisms. In mathematics, physics, and technical systems, the term is directed toward reducing uncertainty, negating entropy, and similar tasks.

Norbert Wiener, the founder of cybernetics, in his early works did not provide a definition of “information” [N. Wiener, *Cybernetics*, Moscow, 1958]. He held that information is neither matter nor energy but something distinct—*information*—and because of this, the term came to be regarded as belonging to the same class of fundamental categories as “life,” “consciousness,” or “motion.” Naturally, this made it difficult to delimit the concept and led to numerous authorial interpretations. In later works, Wiener did provide a definition, linking “information” to human sensory, intellectual, and subjective perception, thereby treating information within the framework of human mental activity.

According to Wiener, in cybernetics and systems theory, the term reflects the unity of syntactic, semantic, and pragmatic characteristics and denotes “the description of the content that we receive from the external world in the process of adapting ourselves and our senses to it” [N. Wiener, *The Human Use of Human Beings*, St. Petersburg, 2001]. In other words, information consists of data obtained from the external world (signs,

symbols, models, images, and other means of representing the forms and content of objects and phenomena), which, through the use of appropriate tools and methods (representations, knowledge, experience, thinking, imagination), allow us to reveal the meaning of these designations and uncover the content of the object or phenomenon.

Thus, Wiener believed that “information is the designation of the content that we receive from the external world in the process of adapting ourselves and our senses to it.” The subject receives certain designations—signs, images, etc.—from the object; once perceived by the senses, these designations make it possible to uncover the content of the object, its characteristics—that is, to recognize it. At this point, the object becomes known: either it corresponds to pre-existing (“old”) knowledge stored in memory, or new knowledge about a previously unknown object is formed. In either case, this knowledge is preserved in memory, may be reproduced, and can be transferred to various material carriers in the form of text, drawings, tables, graphs, images, videos, oral speech, etc., and may even be embodied in artificial objects.

From this it follows that information serves as Wiener’s “designation of content” only when that designation is perceived by an individual—only when it

becomes *their* information. Otherwise, these signs, images, and messages remain merely designations. According to Wiener, both “information” and “knowledge” are to be considered in the context of human mental activity.

This interpretation of “information,” in our view, is constructive because it establishes a link between the concepts “information” and “knowledge.” These two categories are closely correlated: **information**, through memory, thinking, and imagination, may be transformed into **knowledge**, and **knowledge**, when transferred to material carriers, may become **information**.

“Knowledge” should be understood as a system of concepts acquired by a person in the process of thinking and retained in memory throughout life and learning. This system is represented in the form of theories, methods, ideas, concepts, images, etc., and it is employed in solving both theoretical and practical tasks. In the interaction of “information” and “knowledge,” their differences also become evident.

2. The Difference Between “Information” and “Knowledge” and Their Mutual Reversibility

How do “information” and “knowledge” interact, and how do they differ?

Once again: from an external object, a human receives data or designations in the form of signs, images, etc. When these are perceived and interpreted by the senses, they make it possible to uncover the content and characteristics of the object. These designations are then adapted to knowledge already stored in memory. We may thus recognize the object as already known (corresponding to earlier knowledge) or new knowledge is formed. In either case, knowledge is preserved in memory and may be reproduced in various representational forms.

Thus, *information is the designation of content*, and only when it is perceived and understood does this designation become information for the individual—through the individual’s senses, intellect, experience, and cognitive abilities. Here we see both the difference between information and knowledge and their mutual reversibility.

As for “knowledge”—and especially the acquisition of new knowledge—this process is always connected with thinking: the mental reflection of reality, past experience,

and its decoding into images, models, symbols, relations, and structures. Thinking consists of abstraction, comparison, analysis, generalization, evaluation, and selection. It is not only a theoretical reflection of reality—represented in concepts, judgments, theories, hypotheses—but also a basis for solving practical problems.

From the standpoint of epistemological analysis (what knowledge is, how it differs from information, how knowledge is formed, etc.), knowledge is the result of the cognitive process. It has long been noted that cognition is connected with the phenomenon of information, and therefore the two terms are sometimes equated in the literature.

However, such an equivalence is not entirely correct, for it distorts the role of the subject in cognition, who *selectively* extracts information from the surrounding world.

Nevertheless, the synonymy of “information” and “knowledge” is acceptable in certain cases because their closeness—even near equivalence—corresponds to everyday cognition and is convenient when explaining phenomena such as the “circulation of knowledge and the emergence of IP objects as objectified RIA,” etc.

Yet, understanding information as a generic category and knowledge as a species belonging to that category is

permissible only at a coarse level of approximation. The key difference lies in the following:

- In cybernetics, information theory, and thermodynamics, **information** consists of *objective structures of ordered diversity*.
- In contrast, **knowledge** is *subjective*.

If natural information is primary, then once processed by the subject it becomes knowledge (secondary). Conversely, once knowledge is objectified, it becomes primary, and information about it becomes secondary. Thus, in the transitions “information → knowledge” and “knowledge → information,” or in the processes of the *subjectivization* of information and *objectivization* of knowledge, information appears to exist outside the intellect, while knowledge exists within it.

Information, as an external factor of cognition, exists as ordered structures of living and non-living nature, and in linguistic representations of socio-cultural reality (works, technologies, etc.). When selectively extracted by the subject—either empirically (through perceptions and sensations) or through abstract-theoretical thinking based on acquired theoretical constructs (concepts, theories, etc.)—information is processed into new knowledge.

This new knowledge, through linguistic means and other forms, when objectified, again becomes accessible information (subject to IP-use requirements). Thinking

forms new knowledge based on the subject's internal pre-existing knowledge, while empirical experience forms knowledge through the subjectivization of sensory input. Thus, there is a cyclical relationship between information and knowledge.

Information processes exist not only in society but also in nature, confirming Wiener's well-known statement:

“Information is information, not matter and not energy.”

Research on the relationship between knowledge and information within the technological concept of intellect has shown that the construction of new knowledge occurs both at the empirical level and through thinking (see V. F. Yulov, *Thinking in the Context of Consciousness*, Moscow, Academic Project, 2005).

Thinking is activated only in a problematic situation—when the subject encounters a problem based on subjectivized information or knowledge.

If the empirical experience deals with real objects and information, the subject of thinking is not reality itself but the subject's already existing knowledge. Thus, thinking cannot work autonomously from empirical experience: information and knowledge complement one another.

Through the primary subjectivization of information, knowledge arises in the form of perceptions and

sensations. If this knowledge contradicts existing knowledge and the subject cannot solve a problem, the intellect switches into the mode of thinking, and through an act of inquiry the problem is solved. This produces new knowledge—a secondary subjectivization, in which the results of the primary subjectivization are transformed through thinking into secondary knowledge, often verbal, later used to objectify knowledge into socio-cultural information. Here the activity of empirical experience is again required.

The Anglo-American scholar Gregory Bateson introduced the concept of a “pattern” into epistemology. Since the world consists of variable and invariant elements, a pattern is an invariant structure of information that any living organism, given appropriate psychophysical organization, can extract.

For example:

- In copyright, a musical theme can be played in different keys without losing its essential features—because the melody has an invariant core.
- In IP, trademark registration also relies on recognizing such invariant elements.

“Perceiving” means fixing certain parameters of invariance within the flow of stimuli, along with certain parameters of variation.

If empirical experience is dominated by subjectivization and evaluation of information, then thinking develops these sensations and perceptions into more complex forms of knowledge, with language playing a crucial role. In cognition, language serves as a necessary mediator between empirical experience—where information is given to a person in the form of sensations and perceptions—and thinking, which gives these empirical products a completed form as a conceptual structure. Language not only expands human cognitive capacities (allowing knowledge to become an internal object of thought) but also enables knowledge to be objectified in extra-somatic carriers, thereby expanding the capabilities of the human mind.

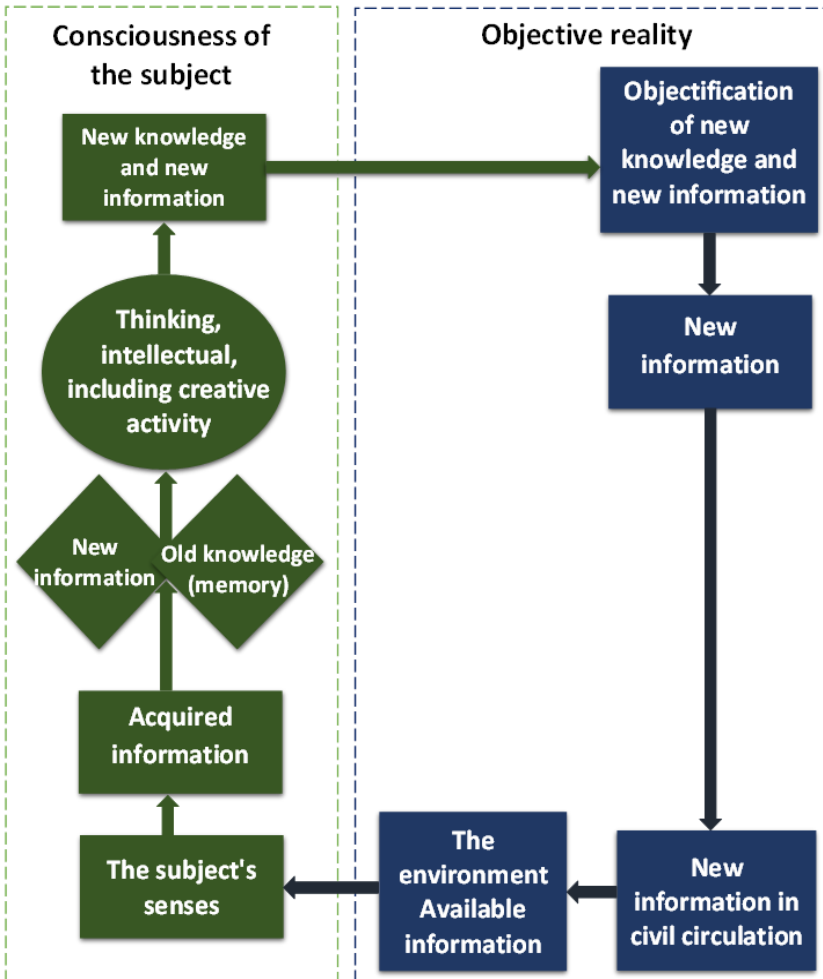
If in empirical experience the subjectivization and evaluation of information prevail, then in thinking the sensations and perceptions are further developed into complex forms of knowledge, where language plays a significant role. In the process of cognition, language acts as a necessary intermediary between empirical experience—where information about the world is presented to the person in the form of sensations and perceptions—and thinking, which gives these empirical products a complete form in the shape of a defined concept.

Language not only greatly expanded the cognitive abilities of the human being by allowing a person to transform their knowledge into an internal mental object; it also helps to objectify knowledge in extra-somatic carriers, thereby expanding the capabilities of the human brain. Language enables a person not to store all necessary information within themselves but to store it outside themselves, while preserving the ability to consult the required source at any time.

The objectivization of knowledge into socio-cultural information is possible not only in linguistic form but also in the form of **artifacts**, which may be embodied in tools, technical devices, social institutions (family, the state, labor unions, etc.), and electronic forms of information storage.

In conclusion of this section, let us return to the previously examined scheme of the “circulation of knowledge,” viewed earlier through the lens of the emergence of IP objects. However, unlike the earlier scheme, the emphasis here will be placed on the interaction of the concepts “information” and “knowledge.” A new version of this circulation scheme is presented below. We emphasize that this circulation of knowledge is ensured through the **information-carrier**.

3. Circulation of Knowledge Through the Information Carrier



Based on what constitutes the foundation of knowledge and the perspective from which it is analyzed—namely, how in the cognitive process information is transformed into knowledge within human consciousness and, consequently, how the concept of “knowledge” is defined—several approaches may be identified.

First, **knowledge** may be understood as the resulting outcome of the human cognitive process. Second, **knowledge** may be interpreted as the generalized result and organization of information—a specific product of the utilization of information. Third, knowledge may be seen as the possession by a subject of certain ideas, theories, concepts, methods, and hypotheses, on the basis of which the subject carries out their activity.

These approaches, to varying degrees, rely on the relationship between information and knowledge. They express the subjective character of knowledge and reflect, through knowledge, the surrounding reality in human consciousness as a result of processing information in the form of representations, images, and judgments that are consolidated in the subject’s activity.

It should be emphasized that knowledge contained in fixed sources is, for the subject, merely **information**, and cannot be used unless it is comprehended in the subject's cognitive process. In other words, the wealth of

accumulated knowledge recorded in sources cannot simply be “transferred”; it must be **assimilated**. Until this occurs, such knowledge remains merely accessible information to the individual. Undoubtedly, such knowledge today can be stored on various carriers and not necessarily in the subject’s memory. However, its use becomes possible only after assimilation—after the transition from accessible information into the category of the subject’s knowledge.

Thus, accessible information—including both information stored on carriers and the subject’s perceptions—consists of data received by the subject about an object of inquiry. This information is interpreted and adapted in the course of thinking to the knowledge stored in memory, enabling the acquisition of new knowledge when solving practical problems. When the subject codifies newly acquired knowledge, he transforms it into information accessible to others, or enables other subjects to expand the volume of their personal knowledge. This process of circulation—or cycle—of knowledge is realized through the transition of new knowledge into the category of accessible information. It is precisely this information that serves as the **carrier** or means of transmitting knowledge from one subject to another. Knowledge itself, however, is used for decision-making in the given processes and tasks.

Thus, we observe a **cyclical interrelation** between information and knowledge:

- information becomes knowledge when it is processed by the subject (the process of **subjectivization of information**);
- knowledge is transformed by the subject into socio-cultural information through language and other sign forms (the process of **objectivization of knowledge**).

The subjectivization of information into knowledge and the objectivization of knowledge into socio-cultural information are two distinct yet inseparable parts of any cognitive process, as well as of communicative acts, both in nature and in the socio-cultural environment. In nature itself, as is known, no scientific facts exist in a ready-made form, nor do scientific laws and theories. These arise through the subjectivization of natural information—either through direct observation of a phenomenon or through the course of scientific experimentation using induction and deduction. In both cases, such operations are employed as extracting patterns from sensory data, subjectivizing them into knowledge in the form of judgments, grouping, classifying, and comparing knowledge—facts.

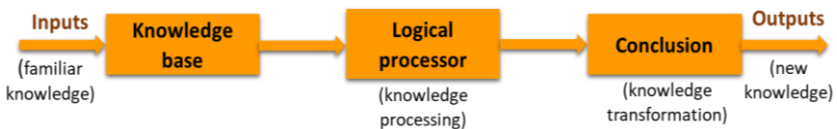
The establishment of scientific facts coincides with the sequence of intellectual acts previously described.

III. ON THE USE OF ARTIFICIAL INTELLIGENCE (AI) IN THE FIELD OF IP

1. AI from the Perspective of a Systems-Cybernetic Approach

The foundation of AI is knowledge, which is the cornerstone of the IP system, since AI functions through the processing of existing knowledge and its transformation into new knowledge via results of intellectual activity (RIA).

This occurs according to the well-known schema of the “black box,” widely used in systems analysis.



The knowledge base is formed on the basis of information introduced from the outside through the inputs, and its content is enriched by experts through so-called expert knowledge, which is represented in the form of productions that connect the “input–output” relationship.



Example. “If $X = a$, then $Y = b$.”

In cases where a and b are ordinary numerical values, i.e., there exists a one-to-one correspondence between the input and the output (for example, $a = 3$, $b = 9$), a functional relationship arises: $y = f(x)$. Thus, when $a = 3$ and $b = 9$, we obtain $y = x^2$, that is, $f(x) = x^2$.

2. Boolean Algebra and the Operation of Implication

To proceed further, we must understand:

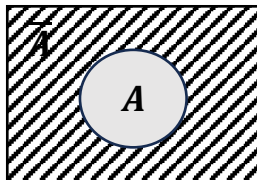
a) what the statement “If X ..., then Y ” means;

b) how the statement “If X ..., then Y ” is interpreted when the values of X and Y are ordinary (crisp) propositions, and how it is interpreted when they are approximate (fuzzy) linguistic propositions.

To do this, we shall give an example linking the above to mathematical logic and Boolean algebra, and also recall certain facts from logic and Boolean algebra that make it possible to analyze propositions.

Three operations play a fundamental role here: **negation** (“-”), “**and**”, “**or**”.

If we have a proposition A , then its negation “not A ” is usually written as \bar{A} , and is conveniently illustrated using an Euler–Venn diagram, where the shaded region represents the negation of proposition A (shown as a circle). In other words, if proposition A is “true,” then \bar{A} is “false,” and vice versa.



A is shaded

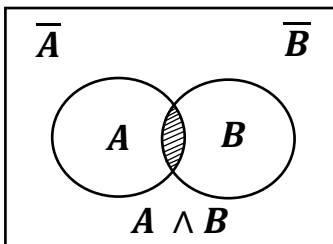
For example, “is a protectable IP object” and “is not a protectable IP object.”

The truth table for the operation “negation” is as follows:

A	\bar{A}
1	0
0	1

If we are dealing with two propositions A and B , then the logical operation of **conjunction** (logical multiplication), denoted as “and” or “ \wedge ”, means that when both A and B are present, the conjunction $A \wedge B$ is represented as the intersection of these two propositions and is illustrated by a diagram (**the shaded region**).

In other words, the operation $A \wedge B$ is true if and only if both statements A and B are true simultaneously.



$A \wedge B$ is shaded

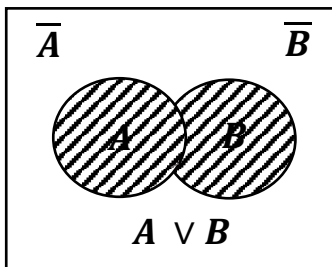
For example, “a protectable IP object” and “RIA.” It is easy to see that conjunction corresponds to the multiplication of the numbers 0 (false) and 1 (true).

The truth table for the operation of **conjunction** is as follows:

A	B	$A \wedge B$
1	1	1
1	0	0
0	1	0

In general, the truth value of $A \wedge B$ is the result of multiplying the truth values of A and B .

If we are dealing with the operation “or,” called **disjunction** and denoted by \vee (logical addition), then $A \vee B$ is true when A is true, or B is true, or both are true. Thus, $A \vee B$ is false if and only if both propositions A and B are false simultaneously (the shaded region of the diagram).



$A \vee B$ is shaded

The truth table for the operation “disjunction” (“ \vee ”, “or”) is as follows:

A	B	$A \vee B$
1	1	1
1	0	1
0	1	1

Thus, the truth value of $A \vee B$ is the result of adding the truth value of A and the truth value of B .

For example, let us compare the two propositions “RIA” and “Protectable IP object.” It is easy to see from the truth table of the disjunction operation “ \vee ” that, within Boolean (binary) algebra—except for the first row—the remaining rows represent the result of adding the two numbers 0 and 1. The first row, which equals 1, is explained by the fact that the value “true” is represented by 1 and nothing more.

The primary information presented above concerning the basic operations allows us to proceed to the binary logical operation that interests us—implication—which plays a crucial role in fuzzy logic. Implication assigns a truth value to an implicative proposition based on the truth or falsehood of its component propositions and is widely used for defining various concepts and regularities.

Let us therefore consider the classical implication $A \rightarrow B$, developed analogues of which play an important role in natural language, in reasoning, and in inference. In this case, the premise A and the conclusion (consequence) B play the following roles:

A is a sufficient condition for B B is a necessary condition for A	$A \rightarrow B$ is equivalent to $\bar{A} \vee B$, although at first glance it might seem that it should correspond to the formula $\neg(A \wedge \bar{B})$.
---	--

A	B	$A \rightarrow B$	$\bar{A} \vee B$	$\neg(A \wedge \bar{B})$
1	1	1	1	1
1	0	0	0	0
0	1	1	1	1
0	0	1	1	1

The truth table for $A \rightarrow B$ has been provided above.

As follows from what has been said, an implicative statement may be replaced by an equivalent statement without implication symbols. It should be noted that in many languages, including Azerbaijani and Russian, the construction “If A , then B ” is **also** expressed as “ B , since A ,” “ B , because A ,” **or** “Given A , B will occur.” This

indicates that A is a sufficient condition for B , and B is a necessary condition for A .

The truth table of $A \rightarrow B$ shows that from a true proposition A , a true proposition B follows.

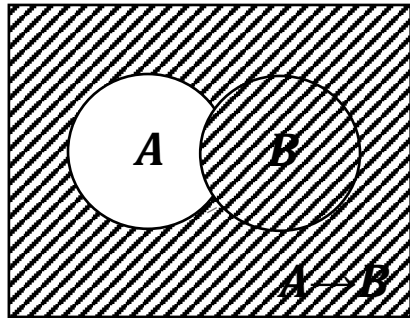
A false proposition A , however, implies both a false and a true proposition B .

According to the table, the statements are considered true when A is false and B is true, and when A is false and B is false.

This reflects the fact that from a false proposition one can derive both a correct and an incorrect conclusion.

The truth table for implication, as noted above, together with the corresponding Euler–Venn diagram, is represented as follows:

A	B	$A \rightarrow B$
1	1	1
1	0	0
0	1	1
0	0	1



$A \rightarrow B$ is shaded

$$A \rightarrow B \equiv \bar{A} \vee B$$

Two statements related to IP are considered:

A – “to be an object of protectable intellectual property” (OIP);

B – “to be a result of intellectual activity and the means of individualization equated to them” (RIA).

Let us take into account that the protection of RIA as OIP objects is ensured as follows:

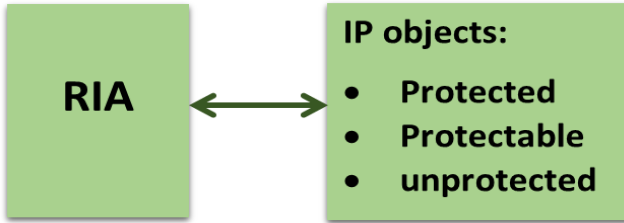
First:

a) **by law** (upon satisfying the requirement of objectification);

b) **through the procedures** of patenting or establishing a trade secret regime — in this case, the RIA becomes a protectable IP object.

Second, there may exist protectable objects that can become IP objects after completion of the required procedures that establish exclusive rights over the object. We should also note that IP rights, due to their dualistic nature, apply specifically to **intangible RIA**, i.e., RIA are understood both as objectively expressed results and as intangible intellectual results.

Third, there exists a group of RIA that are **not protected as IP objects**, but are instead protected within the framework of **civil law**, meaning that from the standpoint of IP they are not protectable. Schematically, the above can be represented as follows:



Let us consider the classical implication: “If OIP, then RIA,” taking into account that...



A protectable IP object (OIP) is **always** an RIA, but the reverse is not necessarily true.

The truth table for the statement “If OIP, then RIA” is presented as follows:

<i>A</i>	<i>B</i>	$A \rightarrow B$	Comment	
OIP	RIA	OIP \rightarrow RIA		
1	1	1	Protected IP objects	If the premise is true, the conclusion is true, but a false conclusion leads to a contradiction
1	0	0	contradiction with the original implication	
0	1	1	Protectable IP objects	"If it is not IP objects, then it does not matter whether it is RIA or not"
0	0	1	Unprotected IP objects	"If there is no IP objects, then there is no RIA"

Let us compare and analyze the two implications 1 and 2, that is, by interchanging the premise and the conclusion.

<p>1. "If IP objects, then RIA" IP objects (IPR objects)</p> <ol style="list-style-type: none"> 1. IP objects must be RIA 2. If IP objects=premise and RIA=consequence, then the case IP objects=1 and RIA=0 is a contradiction 	<p>2. If RIA, then IP objects</p> <p>RIA</p> <ol style="list-style-type: none"> 1. RIA may not be IP objects 2. If RIA=premise and IP objects=consequence, then the case RIA=1 and IP objects=0 is not a contradiction, since it relates to protectable and unprotectable IP objects.
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The contradictions that arise in the case of "If RIA, then OIP" indicate the correctness of the implication "If OIP, then RIA" (with the premise and conclusion chosen appropriately).

3. Classical Boolean Implication and Modus Ponens: Comparison and Connection with the max–min Composition

Let us return to classical Boolean logic:

A	B	$A \rightarrow B$ (classical)	$\bar{A} \vee B$
1	1	1	1
1	0	0	0
0	1	1	1
0	0	1	1

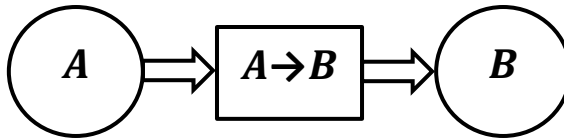
} coincidence

Now let us consider *modus ponens*, according to which $B = A \wedge (A \rightarrow B)$: (deduction).

A	B	$A \wedge (A \rightarrow B)$ (modus ponens)	$A \wedge B$
1	1	1	1
1	0	0	0
0	1	0	0
0	0	0	0

} coincidence

Graphically, we can represent it as follows:



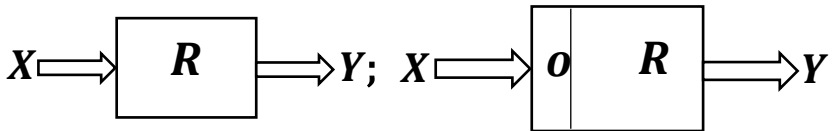
As can be seen, in modus ponens the “optimistic” results of classical implication (rows III and IV of the truth table) are modified, and the truth values of the implication are reduced to zero. This represents a more **cautious strategy**. In our example, “If OIP, then RIA,” the three introduced classes (protectable, protectable-after-procedure, and non-protectable) are not strictly delineated (for instance, “protectable-after-procedure objects” may become either protectable or non-protectable IP objects).

In other words, more accurate statements would be of the following type:

- **If it is apparently an OIP, then it is probably an RIA.**
- **If it is permissible to consider it an OIP, then it is possibly an RIA.**
- **If it is possible that it is not an OIP, then it is conceivable that it is an RIA.**
- **If it is not excluded that it is not an OIP, then it may be not an RIA.**

Otherwise, approximate judgments are required.

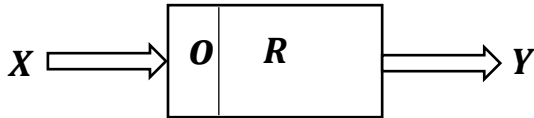
Therefore, in the general case, $X \times Y = R$, meaning that the output Y is related to the input X through a relation R , which is incorporated into the implication (left-hand scheme). If the OIP-related statements are approximate, then a fuzzy relation R (right-hand scheme) applies, represented with the symbol “ \circ ”, which denotes fuzzy composition.



If X and Y are not numerical variables but qualitative or linguistic ones (for example, X ="sufficient," Y ="norm," or expressions such as "possibly," "apparently," etc.), then we are dealing with fuzzy logic.

When reasoning is approximate, the mathematical rule in such cases is also called a **production** or **implication**, denoted by $X \rightarrow Y$, X to Y . Here, X is called the **premise**, and Y the consequence (conclusion). This implication is achieved through the relation R that exists between X and Y . Overall, the information obtained from experts in a given field—later transformed by the modeling expert into a representational model—is initially imprecise, incomplete, and poorly formalized (linguistic).

The relation R must therefore incorporate these fuzzy properties, and thus it is represented in the form:



Here, “ o ” is the composition operator, and as noted above, it expresses the fuzzy relation R between the input X and the output Y .

Let us summarize:

- To the classical implication $A \rightarrow B$ corresponds the logical function $\bar{A} \vee B$.
- According to modus ponens, $B = A \wedge (A \rightarrow B)$, which corresponds to the logical function $A \wedge B$.
- Note that modus ponens as a rule of deduction means: if A is true and the implication $c \rightarrow B$ is true, then the conclusion B is also true.

Conclusion 1. In the generalized logical inference rule, **the truth function of the conclusion B equals the maximum of the truth values of the logical conjunction (the “AND” operation) of the premise A and the implication $A \rightarrow B$:**

$$\mu_B = \max_A(\mu_{A \wedge A \rightarrow B}) = \max_A[\min(\mu_A, \mu_{A \rightarrow B})] = \max_A\{\min[\mu_A, \min(\mu_A, \mu_B)]\}.$$

Let us consider:

$$\mu_B = \max_A [\min (\mu_A, \mu_{A \rightarrow B})] = \max_A [\min (\mu_A, \mu_R)],$$

which expresses μ_B in terms of μ_A and μ_R , i.e., we include the relation R that models the implication $A \rightarrow B$.

Conclusion 2. The max–min composition represents the implementation of modus ponens in fuzzy logic. That is:

- If A is partially true, the conclusion is also partially true.
- The “min” operator limits the truth value of B according to the compatibility of A and the implication. It is, in effect, an analogue of logical conjunction.
- The “max” operator aggregates all possible inference paths—an analogue of selecting the best inference.

Conclusion 3. Fuzzy **modus ponens** is the logical rule “from premise to conclusion” in the form of max–min composition. It is the fuzzy generalization of classical modus ponens: it computes the degree of truth of the conclusion B based on the degree of truth of the premise A and the fuzzy implication $A \rightarrow B$.

4. Fuzziness and Approximate Judgments

How can the described fuzziness be expressed in approximate reasoning?

Example: Many—if not most—people prefer “hot tea.” But what exactly is meant by “hot tea” when the perception of this concept differs from person to person?

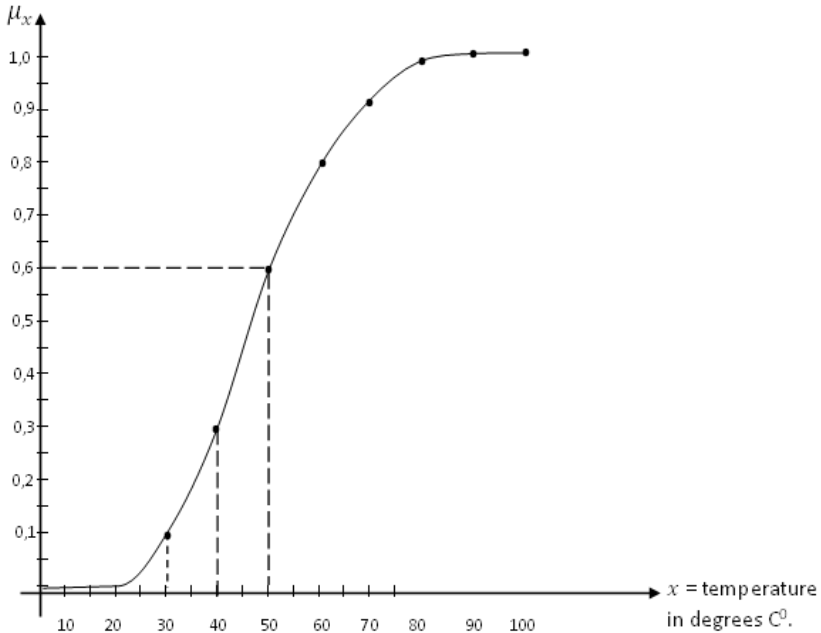
In the language of fuzzy sets, “hot tea” is a **linguistic variable** that takes fuzzy values.

The characterization of such fuzzy values is given by a **membership function** $\mu(x)$, defined on the interval $[0,1]$.

For clarity, let us place on the x -axis a temperature scale from 0 to 100°C. Then the fuzzy set representing “hot tea” looks as follows:

$$\mu(x) = \{0/0; 0/10; 0/20; 0,1/30; 0,3/40; 0,6/50; 0,8/60; 0,9/70; 1/80; 1/90; 1/100\}.$$

Many people consider “hot tea” to begin at 60°C, and according to the fuzzy set above, its membership degree is $\mu = 0,80$. However, some people believe that even at 50°C, tea is already hot. Let us examine the diagram:



Thus, the fuzziness of the concept “hot tea” leads to assigning fuzziness to the corresponding set.

Let us note that the knowledge accumulated in the knowledge base is essential for logical inference in the logic processor.

If the knowledge is represented by ordinary numerical data, including statistical data, then the knowledge base is essentially a **database**, and the logic processor uses it within the framework of **classical logic**, thereby identifying an ordinary (crisp) relation R .

However, if the knowledge is represented in the form of qualitative or, as they are called, **linguistic variables** that take fuzzy values, then in this case as well it is necessary to establish a **fuzzy relation** R within fuzzy logic. In both cases, for logical inference it is necessary to define an implication (crisp or fuzzy) $R: X \rightarrow Y$ between a set of premises X and conclusions Y , which are presented in the form of productions (crisp or fuzzy): "If X is A , then Y is B ."

The implication that incorporates the relation R plays a key role, because it expresses the causal relationship between the premise and the conclusion. We have already examined the case of classical logic; in the case of fuzzy logic, however, there exist several dozen forms of such fuzzy implications.

Examples of Fuzzy Implications:

Zadeh: $\mu_R(x, y) = \max\{\min[\mu_A(x), \mu_B(y)], 1 - \mu_A(x)\}$

Kleene–Dienes: $\mu_R(x, y) = \max\{1 - \mu_A(x), \mu_B(y)\}$
when $\mu_A(x) \geq \mu_B(y)$

Mamdani: $\mu_R(x, y) = \min\{\mu_A(x), \mu_B(y)\}$

Gödel: $\mu_R(x, y) = \begin{cases} 1, & \text{if } \mu_A(x) \leq \mu_B(y) \\ \mu_B(y), & \text{if } \mu_A(x) > \mu_B(y) \end{cases}$

Here, the functions $\mu(\cdot)$ are membership functions of fuzzy variables.

The rules above for computing the fuzzy relation R model—each in its own way—the logic of human decision-making.

To emphasize that the inference is fuzzy, the output is connected to the input through the *max – min* composition rule of Zadeh (other rules also exist):

$$\mu_B(y) = \max_{x \in X} \{ \min[\mu_A(x), \mu_R(x, y)] \}.$$

The composition rule (maximin composition) is a generalization of “modus ponens”. A fuzzy implication—being a generalization of the classical “if A , then B ”—represented as the relation R , and appearing in various forms depending on the chosen logic, constitutes a key concept of fuzzy computation.

Let us stress that these two concepts, based on:

- the composition rule of inference, and
- fuzzy implications,

are essentially representations of **approximate human reasoning and judgment**, and they form the foundation of our ability to understand natural language, recognize complex patterns, and make decisions in uncertain and partially defined environments.

Expert rules (productions), i.e., expert statements, may be accumulated in the knowledge base and used within fuzzy logic for logical inference via the logical processor.

5. The Composition Rule of Inference and Approaches to the Fuzzy Input–Output Relation in Fuzzy Logic

Information about a system, as noted earlier, is obtained from an expert or a group of experts. This stage is called **knowledge acquisition**, and the system as a whole becomes an **expert system**.

The term **fuzzy logic** is used in two senses:

1) Fuzzy logic in the narrow sense

This refers to a logical system that is an extension of many-valued logic. Fuzzy logic in the narrow sense provides the formal foundations for a **graded approach to fuzziness**.

The graded approach reflects a general principle of human reasoning: when determining whether an object possesses a property fully or partially. Since the property is vague (e.g., *almost white spot*, *very powerful engine*), hidden **degrees of intensity** always appear.

2) Fuzzy logic in the broad sense

This expands the narrow definition and aims to create a **mathematical model of natural human reasoning**, where natural language plays a fundamental role. In this sense, fuzzy logic is synonymous with the

theory of fuzzy sets, i.e., sets with vague or blurred boundaries.

In general, fuzzy logic is the result of the **graded approach** to formal logical schemes. Because of this, fuzzy logic allows solving certain problems that are unsolvable in classical (binary) logic.

Example: The Ancient Sorites Paradox (“the heap”)
Sorites – “heap”, Falakros – “bald man”.

One grain of wheat does not make a heap; the same is true for two grains, three grains, and so on—hence, no heap exists.

Paradox of the bald man: A man with no hair or one hair is bald; the same holds for two hairs, three hairs—and therefore all people are bald.

These paradoxes arise when the properties “*being a heap*” or “*being bald*” are treated as precise. Classical binary logic cannot resolve these paradoxes. In fuzzy logic, such paradoxes **do not arise**, because degrees of membership are allowed.

Summary of Key Points:

- **Knowledge acquisition and expert systems:** the role of expert knowledge and “If ... then ...” implications.

- **Fuzzy logic in inference:** the universal character of **max–min composition**, the fuzzy analogue of *modus ponens*.
- **Fuzzy implication in the form of fuzzy productions:** “If X is A , then Y is B ” represents the fuzzy relation $R: X \rightarrow Y$.
- **The implication incorporating the relation R :** key for modeling causal dependencies between premises and conclusions.
- **Multiple logical rules (logics) in fuzzy inference:** different forms of R correspond to different models of human decision-making.
- **Universality of the “max–min composition”.**

Let’s return to fuzzy logics. As noted earlier, there are several dozen types of fuzzy logic. Here are the ones most commonly used in fuzzy logic:

$$\text{Zadeh: } \mu_R(x, y) = \max\{\min[\mu_A(x), \mu_B(y)], 1 - \mu_A(x)\}$$

$$\text{Kleene–Dienes: } \mu_R(x, y) = \max\{1 - \mu_A(x), \mu_B(y)\} \\ \text{when } \mu_A(x) \geq \mu_B(y)$$

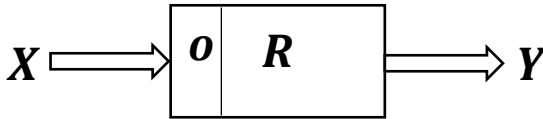
$$\text{Mamdani: } \mu_R(x, y) = \min\{\mu_A(x), \mu_B(y)\}$$

$$\text{Gödel: } \mu_R(x, y) = \begin{cases} 1, & \text{if } \mu_A(x) \leq \mu_B(y) \\ \mu_B(y), & \text{if } \mu_A(x) > \mu_B(y) \end{cases}$$

Here, the functions $\mu(\cdot)$ are membership functions of fuzzy variables.

To emphasize that the inference is fuzzy, the output is connected to the input through the *max – min* composition rule of Zadeh (other rules also exist):

$$\mu_B(y) = \max_{x \in X} \{ \min[\mu_A(x), \mu_R(x, y)] \}.$$



A	B	$A \rightarrow B$	modus ponens $B = A \wedge (A \rightarrow B)$	Operation AND $A \wedge B$
1	1	1	1	1
1	0	0	0	0
0	1	1	0	0
0	0	1	0	0

As we have noted, the implication $A \rightarrow B$ corresponds to the logical function $\bar{A} \vee B$. This means that classical implication $A \rightarrow B$ produces an **overly optimistic inference procedure**, because the statement $A \rightarrow B$ is true not only when both A and B are true (as in the operation “AND”), but also when **both A and B are false**, or when **A is false and B is true**.

From this follows the generalized rule of logical inference: the truth function of the conclusion B is equal to the maximum truth value of the conjunction (the “AND” operation) of the premise A and the implication $A \rightarrow B$:

$$\mu_B = \max_A \{ \mu_A \wedge_{A \rightarrow B} \} = \max_A \{ \min [\mu_A, \mu_{A \rightarrow B}] \} = \max_A \{ \min [\mu_A, \min (\mu_A, \mu_B)] \}.$$

Now we can extend this inference algorithm for the implication $A \rightarrow B$ to fuzzy sets.

Fuzzy logical inference is carried out using a fuzzy knowledge base and operations on fuzzy sets. The fuzzy knowledge base, in turn, is formed by domain experts in the form of fuzzy predicate rules or fuzzy productions.

Thus, **fuzzy logical inference** represents an approximation of a dependence $y = f(x_1, x_2, \dots, x_n)$ by means of a fuzzy knowledge base and operations on fuzzy sets. The expression for inference is:

$$\mu_B = \max_A \{ \mu_A \wedge_{A \rightarrow B} \} = \max_A \{ \min [\mu_A, \mu_{A \rightarrow B}] \} = \max_A \{ \min [\mu_A, \min (\mu_A, \mu_B)] \}.$$

A **fuzzy knowledge base** is a collection of logical statements about the influence of factors (x_1, x_2, \dots, x_n) on the response value y , expressed in the form of **predicate rules** (productions or implications):

$$\prod_1: \text{if } x = A_1, \text{ then } y = B_1$$

$$\prod_2: \text{if } x = A_2, \text{ then } y = B_2$$

.....

$$\prod_n: \text{if } x = A_n, \text{ then } y = B_n$$

Here, x is the **input variable**, y is the **output variable**, and A and B are **membership functions**, defined on x and y , respectively.

This collection of predicate rules forms the basis of a **fuzzy relation** XRY , defined on the Cartesian product $X \times Y$, or more generally on the product of the universal sets of input and output variables.

Examples:

- If $x = \text{low}$, i.e., $a \in A$, then $y = \text{medium}$, i.e., $b \in B$.
- If $x = \text{protectable IP object (OIP)}$, then $y = \text{result of intellectual activity (RIA)}$.

It is evident that the formalization of these linguistic statements is expressed through the Cartesian product $A \times B$.

In other words, expert knowledge of the form $A \rightarrow B$ expresses a **fuzzy causal relationship** between premise and conclusion — that is, a fuzzy relation:

$$R = A \rightarrow B$$

Here, “ \rightarrow ” denotes a **fuzzy implication**. A fuzzy implication is a generalization of classical logical

implication (“if A , then B ”) in a context where truth values may take **any value in the interval** $[0,1]$, not only 0 (false) or 1 (true).

Recall that in classical logic the implication $A \rightarrow B$ is false **only** when $A = 1$ and $B = 0$.

In fuzzy logic, the values of A and B may be intermediate. The degree of truth of the implication is determined by the **fuzzy implication function**: $\dot{I}(A, B)$.

In other words, a **fuzzy implication** is a function of two variables:

$$\dot{I}: [0,1] \times [0,1]$$

To make it behave similarly to classical implication, it is required that $\dot{I}(0,0) = 1$; $\dot{I}(1,0) = 0$; $\dot{I}(1,1) = 1$ and that $\dot{I}(A, B)$ should be decreasing in A and increasing in B .

There exist several dozen fuzzy implications. Below are some key examples:

1. Zadeh Implication: $\dot{I}_Z(A, B) = \max(1 - A, B)$

2. Mamdani Implication: $\dot{I}_M(A, B) = \min(A, B)$

3. Gödel Implication: $\dot{I}_G(A, B) = \begin{cases} 1, & \text{if } A \leq B \\ B, & \text{if } A > B \end{cases}$

4. Lukasiewicz Implication:

$$\dot{I}_L(A, B) = \min(1, 1 - A + B)$$

and others.

Example:

$$A = 0,7 \text{ и } B = 0,4. \text{ Then } \dot{I}_Z(0,7; 0,4) = \max(1 - 0,7; 0,4) = 0,4; \dot{I}_M = 0,4; \dot{I}_G = 0,4; \dot{I}_L = 0,7.$$

What is the relation R introduced earlier?

It is a **fuzzy subset** of the Cartesian product $A \times B$ of all premises X and conclusions Y . **This relation can be used to compute the value of the output variable $y \in Y$ when the input variable $x \in X$ changes.**

How is this done? How does fuzzy inference work?

1. We must use the compositional rule of inference, which is a generalization of modus ponens:

$$\bar{B} = \bar{A} \circ R = \bar{A} \circ (A \rightarrow B),$$

where “ \circ ” is the symbol of maximin composition.

This composition operation—like the implication operation—can be implemented in several different ways within fuzzy set algebra, which naturally leads to differences in inference results.

In terms of membership functions, the composition is written as:

$$\mu_B(y) = \max\{\min[\mu_A(x), \mu_R(x, y)]\},$$

where $x \in A, y \in B$.

2. To proceed, we must specify the logical rule used to form the relation R , i.e., choose one of the fuzzy logics:

- Mamdani Logic: $\mu_R(y) = \min_{A \times B} \{\mu_A(x), \mu_B(y)\}$

- Zadeh Logic:

$$\mu_R(x, y) = \max\{\min[\mu_A(x), \mu_B(y)], [1 - \mu_A(x)]\}$$

- Lukasiewicz Logic:

$$\mu_R(x, y) = \min\{1, [1 - \mu_A(x) + \mu_B(y)]\}.$$

- Gödel Logic:

$$\mu_R(x, y) = \begin{cases} 1, & \text{if } \mu_A(x) \leq \mu_B(y) \\ \mu_B(y), & \text{if } \mu_A(x) > \mu_B(y) \end{cases}$$

and others.

Observations

Despite their diversity, fuzzy implications are based on certain principles:

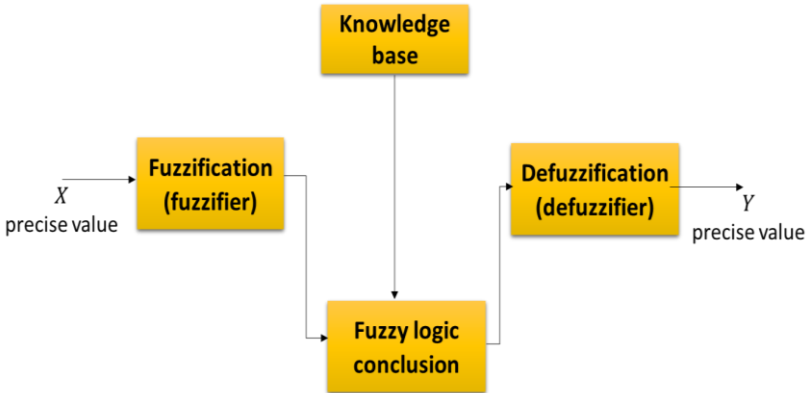
- **Boolean-based implications**, such as Kleene–Dienes and Łukasiewicz.
- **Implications based on intuitionistic logic**, such as Gödel and Gaines.
- **Applied fuzzy implications** widely used in engineering, such as Mamdani and Larsen.

Additionally:

- At the **preliminary stage**, *fuzzification* is performed — introducing fuzziness to crisp inputs.

3. At the final stage, defuzzification is carried out — converting the fuzzy result back to a crisp value. Below is the structure of a fuzzy logical inference system:

4. Stages of Fuzzy Logical Inference



The existence of several dozen variants of fuzzy implication R raises the question of their **effectiveness**. In particular, studies have been conducted to evaluate the expressive quality of these implications according to two criteria.

First, the maximum error introduced by the implication operation must not exceed the maximum error inherent in the linguistic representation of the data.

Second, the fuzzy model constructed using the chosen fuzzy implication must be **robust** with respect to the choice of the membership function form.

The analysis demonstrated that the following fuzzy implications (logics) are the most effective:

Classical (Kleene–Dienes):

$$\mu_R(x, y) = \max\{1 - \mu_A(x), \mu_B(y)\}, \quad \mu_A(x) \geq \mu_B(y)$$

Zadeh:

$$\mu_R(x, y) = \max\{\min[\mu_A(x), \mu_B(y)], [1 - \mu_A(x)]\}$$

Mamdani:

$$\mu_R(x, y) = \min\{\mu_A(x), \mu_B(y)\}$$

Lukasiewicz:

$$\mu_R(x, y) = \min\{1, [1 - \mu_A(x) + \mu_B(y)]\}$$

Gödel:

$$\mu_R(x, y) = \begin{cases} 1, & \text{if } \mu_A(x) \leq \mu_B(y) \\ \mu_B(y), & \text{if } \mu_A(x) > \mu_B(y) \end{cases}$$

and several others.

Thus:

a) A fuzzy implication is a generalization of classical logical implication within fuzzy logic, where the truth value of a statement may take **any value in the interval [0,1]**, rather than only 0 or 1 as in the classical case.

b) Logical reasoning based on fuzzy implication **imitates** the human reasoning process, capturing its approximate and gradational nature.

Neural Network

6. Neural Network: Biological and Artificial Neuron

A neural network (NN) is a computational structure that models certain simplified biological processes typically associated with the functioning of the human brain.

An artificial neuron serves as an analogue of the biological neuron, and a network composed of such artificial units constitutes a neural network model.

A fundamental difference between expert systems (production-type ES) and neural networks lies in the representation of knowledge:

- In expert systems, knowledge is represented **symbolically**—through rules, logical constructions, concepts, and inferences (explicit knowledge representation).
- In neural networks, knowledge is represented **implicitly**, in the form of weight coefficients and the structure of connections between neurons. Such knowledge cannot be directly interpreted without additional analytical methods.

In other words, a neural network may possess the knowledge necessary to solve a task, *but it cannot explain*

why a particular solution was obtained—a phenomenon known as the “transparency” or “interpretability” problem of neural networks.

Biological Neuron.

The human nervous system, including the brain and spinal cord, consists of neurons—specialized cells interconnected by nerve fibers. These fibers transmit electrical impulses between neurons.

Any external stimulus—skin contact, sound, light—is converted into a nerve impulse and transmitted to the brain. Thus, processes of thinking, perception, and motor control are realized as chains of electrical impulses propagating through the network of neurons.

Structure of a Biological Neuron

A biological neuron is a living cell capable of receiving, processing, and transmitting information. It includes:

- **the cell body (soma)** with its nucleus,
- **dendrites**, the many branching projections that receive incoming signals,
- **the axon**, a single long projection through which the generated signal is transmitted to other neurons.

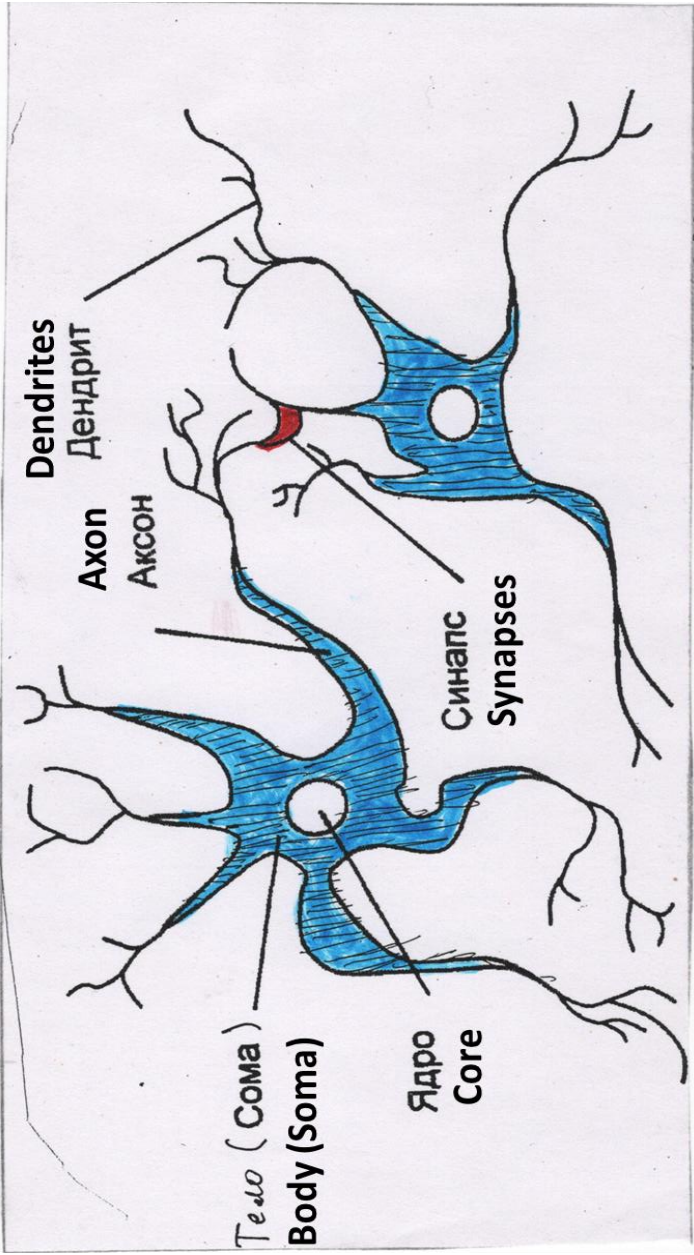
The neuron's nucleus contains genetic information and the molecular mechanisms necessary for synthesizing the substances that sustain the cell's functioning.

How a Biological Neuron Works

1. The neuron receives signals from other neurons through its dendrites.
2. These signals are integrated and processed within the cell body.
3. If the total input exceeds a certain threshold, the neuron generates an electrical impulse (action potential).
4. This impulse travels along the axon and is transmitted to other neurons.
5. At the axon terminals, the signal is passed through **synapses**—specialized structures that regulate the strength and characteristics of the transmitted impulse.

Synapses are crucial because they can amplify or diminish the incoming signal, thus determining whether the next neuron in the chain will fire.

Below is a schematic representation of the interaction between biological neurons.



The figure clearly illustrates the special role of the synapse, which is the elementary structural unit—or link—between two neurons. It is within this functional node that the axonal fibers of one neuron connect with the dendrites of another, forming a signal transmission–reception unit.

The mechanism of inter-neuronal interaction operates as follows: an impulse arriving at the synaptic terminal of the transmitting neuron triggers the release of chemical substances known as **neurotransmitters**. Crossing the synaptic **cleft**, these neurotransmitters can generate electrical impulses in the receiving neuron. Depending on the type of synapse, these impulses may **excite** the postsynaptic neuron or **inhibit** it.

It should be noted that this “dynamic” behavior of the synapse—its ability to vary the strength (weights) of its influence on signal transmission—allows us to speak of its **tuning** as a result of the signals passing through it, or even of its **capacity for learning** based on the activity of the processes in which it participates. Changes in synaptic weights over time represent changes in the behavior of the corresponding neurons, and the accumulated history of these changes essentially constitutes memory, often interpreted as the biological basis of human memory.

It is worth emphasizing that the cerebral cortex contains approximately 10^{11} neurons, each of which is

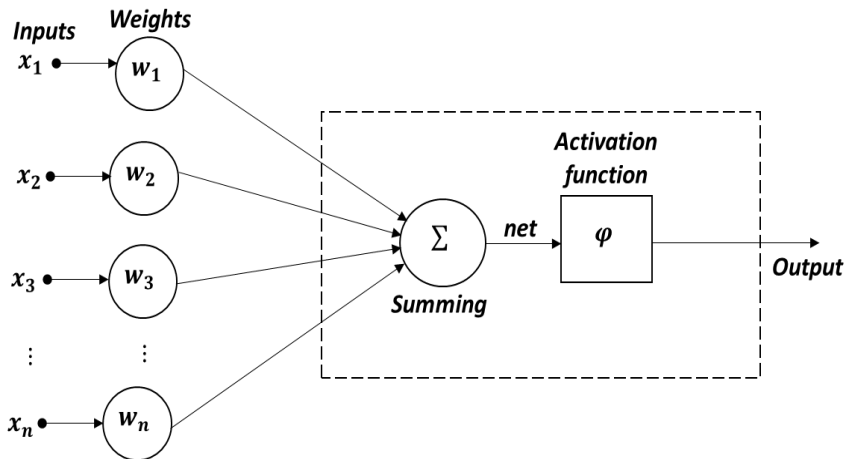
connected to 10^3 – 10^4 other neurons, resulting in a total number of interconnections on the order of 10^{14} – 10^{15} . Neuronal interaction occurs through short bursts of impulses lasting only a few milliseconds, and information is transmitted by means of frequency–impulse modulation.

Artificial Neuron (AN).

An artificial neuron models the functioning of a biological neuron and constitutes a structural unit of an artificial neural network (ANN), which itself is designed according to the organizational and functional principles characteristic of biological neural networks.

Just as in a biological network, an artificial neural network consists of interconnected neurons, though in a substantially simplified form. It also has multiple inputs that receive various signals, which, after being processed, are transmitted to other neurons. In essence, several input signals (parameters) are transformed into a single output signal.

Below is the structure of an artificial neuron:



In this structure, three types of elements are distinguished: synapses (multipliers), a summator, and a nonlinear transformer.

Synapses provide connections between neurons; they multiply the input signal by a numerical value characterizing the strength of the connection (the synaptic weight). The summator performs the addition of signals arriving through synaptic connections from other neurons, as well as external input signals. The nonlinear transformer implements a nonlinear function of a single argument—the output of the summator. This function is called the activation function or the transfer function of the neuron.

In essence, a neuron implements a certain function of a vector argument. Mathematically, this is expressed as:

$$\Sigma = \sum_{i=1}^n W_i x_i + b ; y = \varphi(\Sigma).$$

Here W_i – synaptic weight; $i = \overline{1, n}$ indicates that, in general, there may be n inputs; b – bias term; Σ – summation result; φ – a nonlinear transformation, i.e., the activation function.

Simply transmitting the weighted sum Σ to the output of the neuron would be meaningless, since it must be processed in order to form an appropriate output signal. This is exactly the purpose of the activation **function**, which transforms Σ into a particular number representing the output of the neuron, i.e., $\varphi(\Sigma)$.

In general, the input signal, the weight coefficients, and the bias may take real values; in many applied tasks, however, they may take only certain fixed values. The output (y) depends on the choice of activation function and may be either real-valued or integer-valued.

Synaptic connections with positive weights are called excitatory, while those with negative weights are inhibitory.

The described computational element can be considered a simplified mathematical model of biological neurons. To emphasize the difference between biological and artificial neurons, the latter are sometimes referred to as neuron-like elements or formal neurons.

Given an input signal (Σ) the nonlinear transformer produces an output signal $\varphi(\Sigma)$, which constitutes the neuron's output y .

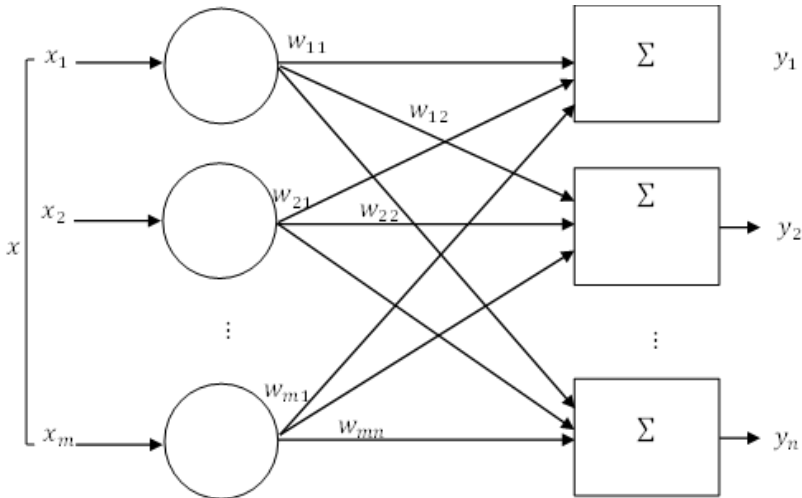
Different types of neurons use different activation functions. The simplest of these is the unit step function: if $\Sigma \geq$ a certain threshold, then $\varphi(\Sigma) = 1$, otherwise 0.

More commonly, the sigmoid function is used as an activation function:

$$\varphi(\Sigma) = \frac{1}{1 + e^{-as}}$$

It is evident that as the parameter a decreases, the sigmoid becomes flatter, and when $a = 0$ it turns into a horizontal line at the level 0,5. As a increases, the sigmoid resembles a unit step function with threshold θ .

Thus, the neuron's output value lies in the interval (0,1). Taking into account multiple inputs, a single-layer neural network has the following appearance:

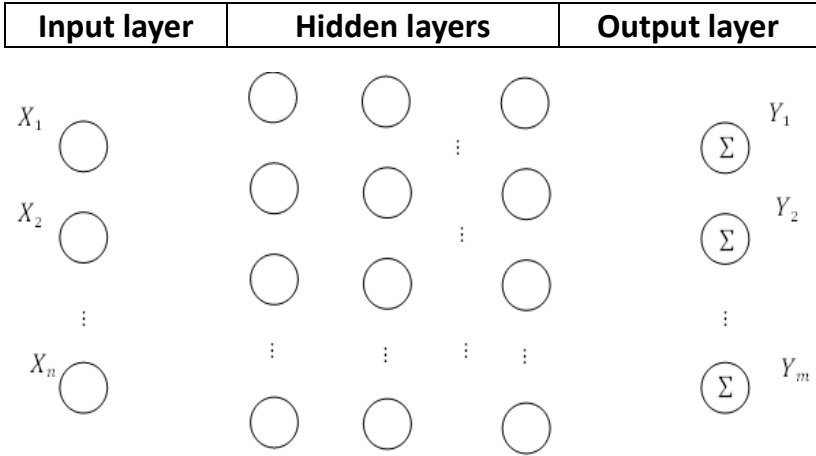


The variables x_1, x_2, \dots, x_n enter the **input layer** (which is not considered an actual layer of the neural network), after which the signals are distributed to the output layer of ordinary neurons. On every edge connecting an input-layer neuron to an output-layer neuron, a number is indicated—the weight of the corresponding connection.

The simplest model of a neuron is called a perceptron.

The illustration above shows a single-layer neural network. It can be seen that signals from the inputs reach the input layer, which, as noted, is usually not counted as a true network layer. From there, they are immediately transmitted to the output layer, which processes the signal and produces an immediate output.

This same principle is used in constructing multilayer networks, which consist of the same input and output layers, but include one or more intermediate (hidden) layers placed between them.



A natural question arises: how exactly are neural networks used, and do they provide an alternative—beyond expert systems (ES)—for representing knowledge and performing logical inference in a system?

The answer is yes, and neural networks themselves constitute this alternative.

The fundamental difference between expert systems (production-rule ES) and neural networks lies in the form in which knowledge is represented—these forms are not only different but, in many respects, conceptually opposite. In expert systems, knowledge representation is symbolic, explicitly capturing human knowledge, skills, and experience through rules (“If... then...”), facts, and symbolic structures. This is explicit knowledge representation. In neural networks,

knowledge is represented in an implicit form, encoded in the network's weight coefficients. Such knowledge cannot be directly interpreted or presented to a human without additional transformations. In other words, a neural network may “possess” knowledge sufficient to solve a task, but it cannot explain why this particular solution was produced.

7. The Fuzzy Neuron and the Fuzzy Neural Network (FNN): Hybridization of Fuzzy Logic and FNN

A standard neural network (NN) is an artificial neural network composed of artificial neurons that are interconnected and connected to the external environment through weighted connections. Because neural networks operate on input–output numerical data, often obtained from measurement or observation, they provide an objective empirical basis for identifying regularities and forming generalizations.

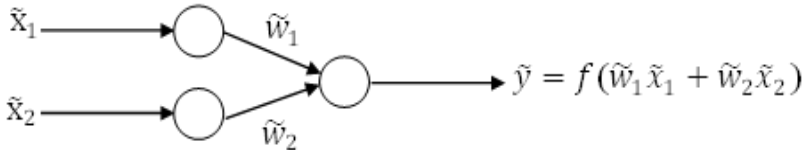
However, a neural network lacks the ability to explicitly represent the functional relationship between the input and the output of a system. The relationship is encoded implicitly in the weights and cannot be interpreted symbolically.

This limitation gives rise to the need for integrating fuzzy production models and neural network models. This process is known as **hybridization**.

How is this achieved? To accomplish hybridization, fuzziness is introduced into various components of a neural network (into the inputs, into the outputs, into the weights of neurons).

This leads to the construction of a fuzzy neuron and, correspondingly, a fuzzy neural network (FNN).

A schematic representation of a fuzzy neuron (i.e., a typical fuzzy neural network architecture) is given below:



Here, \tilde{x}_1 and \tilde{x}_2 are fuzzy inputs, \tilde{w}_1, \tilde{w}_2 are fuzzy weights, and y is the fuzzy output. $\tilde{w}_1 \cdot \tilde{x}_1 = \tilde{z}_1$; $\tilde{w}_2 \cdot \tilde{x}_2 = \tilde{z}_2$.

A fuzzy neural network (FNN) is an equivalent representation of a fuzzy model. Thus, the fuzzy model is transformed into a neural-network form in which its specific characteristics are preserved.

It should be noted that, when classifying such models, two of the most widely used classes are distinguished:

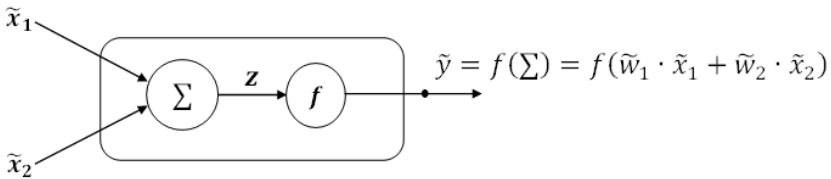
1. Fuzzy Production Networks (FPN),
2. Neuro-Fuzzy Networks (NFN or FNN).

The difference lies in the dominant component: in an FPN, the network is essentially a structured sequence of fuzzy production rules; in an NFN, the network is primarily a sequence of neurons. Hybrid models that incorporate features of both are also possible.

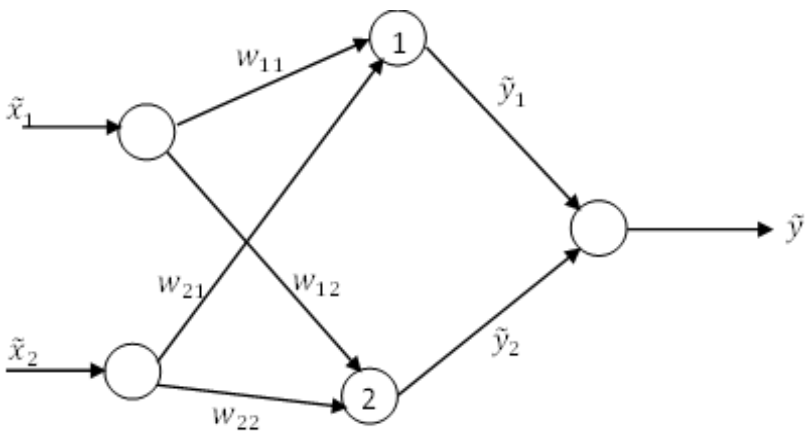
Returning to the previously examined example—that is, a standard FNN: all signals and weights are treated as fuzzy numbers. Two-input neurons do not modify the

input signals, meaning that their outputs remain equal to their inputs. However, the input signals X_1 and X_2 are combined with the weights W_1 and W_2 . This gives: $r_1 = W_1X_1$ and $r_2 = W_2X_2$. The computation of the values r_1 and r_2 is based on Zadeh's extension principle and a nonlinear activation function, usually of the sigmoid type.

A fuzzy neuron can be represented in an equivalent form as follows:

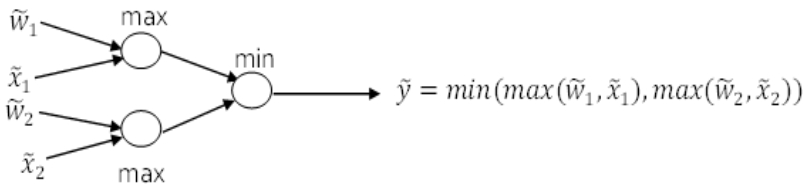


Its analogue for the case of a two-layer fuzzy neural network (FNN) with two inputs is given below:

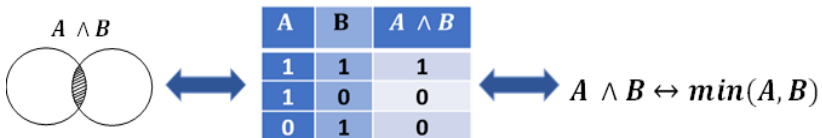


Following V.V.Borisov et al., “Foundations of Hybridization of Fuzzy Models” (Moscow, 2022), we also present examples of neurons that implement fuzzy operations:

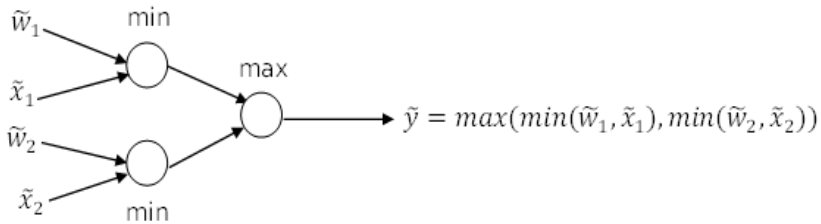
Fuzzy neuron “AND”:



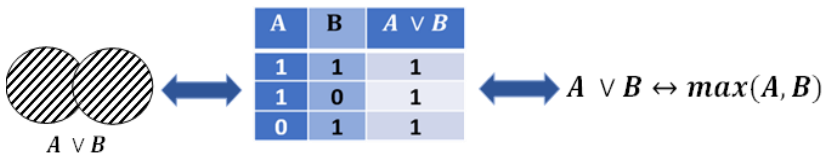
Explanation



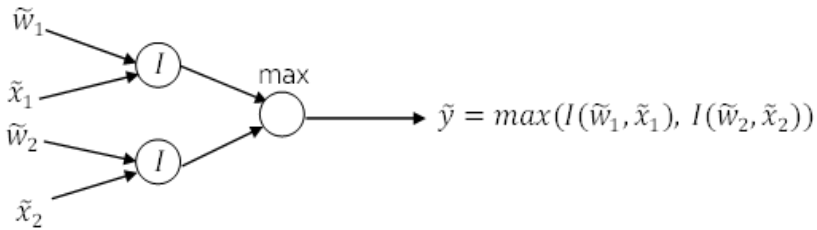
Fuzzy “OR” neuron:



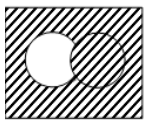
Explanation



Fuzzy Implication Neuron – “OR”:



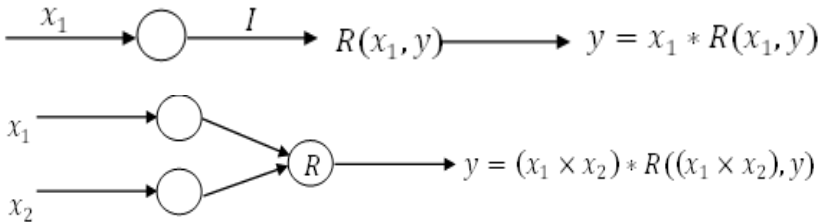
Explanation



A	B	$A \rightarrow B$	$A \vee B$
1	1	1	1
1	0	0	0
0	1	1	1
0	0	1	1

$$A \rightarrow B = \bar{A} \vee B \leftrightarrow \max(\bar{A}, B)$$

Fuzzy neurons for implementing compositional inference rules



In conclusion to these preliminary remarks, we can formulate the main takeaway. Modern AI models rely on fuzzy logic and neural networks, functioning as neuro-fuzzy systems (NFS). This enables them—within the limits of current technological capabilities—to solve various

practical tasks in a way that is analogous to human reasoning.

In linguistic modeling, NFS are oriented toward interpretability and therefore use the Mamdani model, whereas in cases of precise fuzzy modeling, the focus is on accuracy, and the Takagi–Sugeno–Kang model is applied.

IV. “ARTIFICIAL INTELLIGENCE” AND INTELLECTUAL PROPERTY

1. Development of AI and the Legal Issues It Generates

AI technologies are among the greatest achievements in human history. Starting from early precursors of “intelligent” machines—such as the mechanical servant of Philon of Byzantium or Leonardo da Vinci’s mechanical lion and robotic knight—great minds have created such mechanisms, but due to their uniqueness and the absence of true AI, they did not generate **legal** problems.

Today, however, the mass adoption of AI raises key and highly controversial questions, including:

- legal personality of AI;
- moral and legal responsibility for harm caused by AI;
- allocation of rights to objects created with the help of AI; and others.

The experience of common-law countries is particularly important, because in these jurisdictions, the legal system—based not solely on codified rules but on general principles—can usually respond more quickly and efficiently to emerging problems from an economic

perspective, providing solutions that may later be codified in civil-law countries.

At present, from a legal standpoint, two types of IP-related outputs and their creators exist:

- Objects of IP created with the assistance of AI, i.e., involving human participation — non-autonomous AI (the author or inventor is a human, with rights).
- Objects of IP created by AI, i.e., without factual human involvement — autonomous AI (legally a creator is required, but de facto no human creator exists; even if AI is hypothetically granted object-status, legal subjectivity is absent).

A separate category is generative AI, which is included among autonomous AI systems.

Terminological and substantive similarities and differences.

Although related, autonomous AI and generative AI differ conceptually.

Autonomous AI (Autonomous AI)

Systems capable of independently making decisions and performing actions in the real world **without direct human intervention**.

Examples:

- autonomous vehicles,
- industrial robots,
- autonomous drones,

- autonomous medical or energy management systems.

They operate in physical or digital environments and require reliability and safety.

Generative AI (Generative AI)

Models that create new content using probabilistic methods and large datasets. They generate: text, images, audio/video, code, 3D objects.

Examples: GPT models, DALL·E, Stable Diffusion, Midjourney, music generators, generative agents.

Their primary purpose: **creating information analogous to human creativity.**

Similarities

Despite their differences, both share fundamental common parameters:

- Both rely on machine learning and use neural networks, Bayesian models, reinforcement learning, etc.
- Both require training data:
 - generative AI — large datasets (text, images),
 - autonomous AI — sensor data, maps, simulations.
- Both are capable of learning and adaptation.
- Both create risks:
 - generative AI — fakes, deepfakes, copyright infringement,
 - autonomous AI — accidents, faulty decision-making.

- Both require oversight and regulation (EU AI Act, OECD, UNESCO frameworks).

Functional differences:

Autonomous AI: operates under the cycle *perceive* → *analyze* → *act*. Its core task: **independent decision-making and control**.

Generative AI: operates under the cycle *receive prompt* → *generate options* → *select best*. Its core task: **imitation of creativity and data generation**.

The key problem: Legal subjectivity and object-status

In most jurisdictions, including CIS countries, the subject of IP rights is **a human being**. Therefore, a result of intellectual activity created **by AI** cannot be a patentable invention or copyrighted work, because it was not created by a human inventor or author.

With respect to patents, major patent systems (USA, Europe, China, Japan, etc.) function on several axioms:

- **The inventor must be a natural person.**

Definitions of “inventor” in statutes and case law explicitly or implicitly require a human.

- AI may contribute to the creation of an invention but cannot:
 - be listed as an inventor;
 - own rights;
 - assign or transfer exclusive rights.

Thus, protection is available only for **AI-assisted inventions**, not inventions “created by AI itself.”

DABUS cases: the global precedent

The most illustrative example is the series of patent applications filed by S. Thaler’s team in more than 15 countries naming the AI system **DABUS** as the inventor.

Outcomes:

- **European Patent Office (EPO)** — rejection; the Boards of Appeal confirmed that an inventor must be human.
- **UK, USA, Germany, Canada, Saudi Arabia, Taiwan, and others** — applications rejected for lack of a “natural person inventor.”
- **South Africa** — formally granted a patent listing DABUS as the inventor, but without substantive examination; widely viewed as an outlier rather than a legal model.

Main conclusion:

The dominant global trend is **rejection of AI’s inventor status**. Isolated exceptions did not change the international legal landscape.

Major jurisdictions

United States

AI-generated content is **not eligible** for copyright or patent protection if no human creator exists, because only human beings can be authors. AI-assisted creations may

be protected if a person contributed sufficient creative input.

In 2024, the USPTO issued **Inventorship Guidance for AI-Assisted Inventions**, establishing:

- **AI cannot be an inventor.**
- **A human must make a significant creative contribution.**
- **AI is treated as a tool** (similar to simulation software or search systems).
- Patent attorneys now document the human contribution carefully.

Europe (EPO and member states)

Under the IP5 cooperation framework (EPO, USPTO, CNIPA, JPO, KIPO), all offices agree: **the inventor must be a human**, and AI is a tool.

In 2024, the EPO updated its Guidelines for Examination on AI-related inventions, confirming:

- human inventor requirement;
- clarified rules on “technical character” for AI inventions;
- updated sufficiency-of-disclosure requirements for learning models.

Thus, rights protect the *result*, but legal attribution is tied to a human inventor.

United Kingdom

The UK Copyright Act contains a unique provision allowing copyright protection for works generated by a computer; however, **the author is deemed to be the person who arranged for the creation of the work**, not the AI itself.

China

Copyright protection may apply to AI-generated works **if there is human creative input in designing or directing the generation process**. This differs from the USA, but China also does **not** recognize AI as an author.

China, Japan, Korea and others allow patenting of AI-related inventions *only where a human inventor is named*.

Japan (JPO) and Korea (KIPO)

Both offices:

- permit patents for AI-related inventions (models, algorithms, applications),
- explicitly require that the **inventor be a human**.
- **Dedicated sections have been developed in examination guidelines** addressing AI-related inventions, focusing on **technical effect** and **sufficiency of disclosure** (description of the model, data, parameters).

- At the same time, under the law, **the inventor must be a human**, while AI is treated as a “high-complexity tool.”
- The general trend in Asia: a **maximally liberal approach** to the *patentability* of AI solutions, but a **conservative approach** to *inventorship and ownership* (subjects of rights).

Russia

Current legislation directly links authorship to a natural person (Art. 1228 of the Russian Civil Code). Therefore, works created by AI **without human participation** formally do **not** fall under copyright protection.

Russian courts have not yet established case law on this matter, but since 2023–2024 the topic has been actively discussed. According to expert commentary, the law does not recognize AI as an author, and rights to AI-generated output remain legally uncertain.

In 2024, the Russian government drafted amendments to the Civil Code specifically addressing AI-generated content. It is reported that the draft proposes that **responsibility for works created by neural networks lies with the end user** of the technology and clarifies the allocation of income from such works.

A major debate concerns: **Who should own the rights and receive remuneration — the creators of the algorithm or the users generating content with AI?**

Although no final law has been adopted yet, the very fact that such provisions are being prepared shows an intention to eliminate the legal vacuum and to determine who holds copyright to AI-generated works (e.g., the proposals suggest assigning rights to human developers or operators, but not to machines).

Azerbaijan: AI Strategy 2025–2028 and Intellectual Property

The recently adopted **Artificial Intelligence Development Strategy of the Republic of Azerbaijan for 2025–2028** includes provisions indirectly related to IP. The Strategy outlines priorities for developing AI in the country (economy, public administration, education, infrastructure). It envisions:

- updating the regulatory framework,
- adopting a **Law on Artificial Intelligence** covering liability, data ethics, and establishing an AI Academy.

Although copyright, patent law, and IP rights are not explicitly detailed in publicly available parts of the Strategy, several provisions connect to IP indirectly:

Azerbaijan's position is to **develop AI in harmony with the protection of intellectual property**. The Strategy aims to create conditions for AI innovation (tax incentives,

infrastructure, open data), while simultaneously establishing a legal framework addressing emerging challenges, including IP.

In the coming years, Azerbaijan may introduce:

- clarifications or amendments to copyright and patent laws regarding AI-generated content;
- mechanisms for registering rights to AI-related developments;
- pilot projects for collective rights management for data or AI-generated output (potentially via the Intellectual Property Agency of Azerbaijan).

International Level

At the international level (WIPO, UNESCO), no binding rules exist yet, but active discussion continues on the “authorship and inventorship problem” in the age of AI.

General conclusion:

The global trend is that **IP objects created by AI are protected only when sufficient human contribution is present.**

If the result is produced by autonomous AI, rights do **not** arise — or are attributed to the person who organized the process (e.g., UK).

2. Legal Personality (Subjectivity) of AI

Court practice

Courts in most countries uniformly state that **AI cannot independently possess the status of an author or inventor**. This is so even though common-law precedent systems generally offer more flexible and economically efficient solutions.

According to courts, any change in approach is possible **only through legislative reform**.

Patent laws define “inventor” as a **natural person**, and copyright laws similarly define “author” as a human being.

Courts consistently conclude:

- A machine or algorithm lacks legal personality.
- It cannot bear duties or exercise rights.
- Therefore, AI cannot be included in IP-rights schemes.

The originality requirement (creative contribution) and the inventive step are tied to a human being; creative expression reflects human personality, and originality represents the “author’s personal imprint.”

Recognizing AI as a legal person would contradict the purpose of the IP system, which is to **incentivize human creativity** — something unnatural for machines.

Result:

As of early 2025, **no major jurisdiction** recognizes AI as an independent rightsholder in IP (i.e., as an author or inventor).

Where lies the core problem: subjectivity and object-status of AI?

- In most jurisdictions, including CIS countries, **the subject of IP rights is a human**. Accordingly, an output created by AI cannot be protected by patent or copyright law because it is not created by a human inventor or author.
- In Azerbaijan, the AI Strategy 2025–2028 plans a future legal framework addressing responsibility, ethics, and possibly IP questions.
- In all major patent systems (USA, Europe, China, Japan):
 - **Inventors must be physical persons.**
 - AI may participate in creation but cannot be listed as an inventor, own rights, or assign them.
 - Protection applies only to **AI-assisted inventions**.
- The DABUS case remains the key global precedent.
- Major jurisdictions (USA, EU, UK, China, Japan, Korea, Russia, etc.) all follow this principle.

General Conclusion:

IP objects created by AI are protected only when there is sufficient human contribution. If the result is

produced autonomously by AI, rights do not arise — or are attributed to the person who organized the process (UK).

3. Expectations for the Future

United Kingdom

In 2020–2021, public consultations were held on possible amendments. The final report concluded that **no changes to the definition of “inventor”** would be made. Debate on copyright is ongoing (as of 2023).

European Union

In 2020, the European Parliament opposed granting AI any form of electronic legal personality. Recommendations were:

- maintain existing protection for technical inventions generated with AI;
- assign rights to humans (developers or operators), not AI;
- for copyright: without human contribution, a work fails the originality requirement.

United States

USPTO’s public consultations (2019–2020) concluded that the definition of “inventor” should remain unchanged.

In March 2023, the U.S. Copyright Office issued guidance requiring **human authorship** for registration of AI-assisted works.

The U.S. is refining practice but avoids altering fundamental statutory principles.

Other countries

China, Australia — no legislative changes.

WIPO

Since 2019, WIPO has hosted extensive discussions under the “**Conversation on IP and AI**” initiative. Proposals range from:

- maintaining the status quo,
- to introducing new sui generis rights for data or AI-generated output.

However, these remain conceptual.

A central concern: Recognition of AI as an inventor in one jurisdiction would create uncertainty in others — making **international harmonization essential**.

Key themes in WIPO discussions:

- Should AI ever be recognized as an inventor (wholly or jointly with humans)?
- Effects on incentives, responsibility, and benefit allocation.
- Risks of “patent clutter” if AI begins generating inventions at scale.

Current consensus: It is premature and risky to alter the human-centered nature of the IP system. Countries prefer **guidelines and clarifications**, not radical legislative reform.

Overall Conclusion

No country has yet amended its legislation to include AI as a subject eligible to be an author or inventor. The global system remains **anthropocentric** — only humans are creators.

Legislators hold a cautious position: while various improvements are proposed, AI remains a **tool** in the hands of humans.

Thus, the prevailing global model is **conservative**, where rights to AI-generated IP are mediated through a human (developer, owner, or user). Yet the issue remains open and “awaiting legislative resolution.”

Possible scenarios for the near future

a) Amendments allowing AI to be *listed* in applications (with rights assigned to a human or corporate owner).

b) Creation of new forms of protection.

c) A strict reaffirmation — possibly via international treaties — of the principle that **no human contribution = no IP protection** (the current U.S. and EU model).

The difficulty lies in the fact that this is not only a legal issue, but also a philosophical, ethical, and economic one.

Nevertheless, IP law continues to evolve.

4. Philosophical and Legal Problems of Recognizing the Legal Personality of AI (Brief Analysis)

There exist deep philosophical-legal, ethical and ontological problems. This concerns not only the letter of existing law, but also questions such as:

- who or what deserves the status of a bearer of rights;

- by what criteria we determine “personhood” in the legal and moral sense;

- whether the nature of AI, from the standpoint of the philosophy of law, allows it to be considered a subject of rights;

- from the standpoint of ethics, what the moral status of thinking machines would mean;

- from the standpoint of ontology — what the being of AI is, whether its level of autonomy and “rationality” is sufficient to include it in the category of subjects; etc.

Below are the arguments **for** and **against** recognizing AI as a subject of law.

1. Arguments in Favor of Recognizing AI as a Subject of Law

1.1. Ethical Argument

If autonomous AI reaches the level of strong AI, i.e., acquires human-level intelligence, self-awareness, and

the capacity to experience sensations and emotions, then from an ethical perspective it may possess a certain moral status (if AI is capable of suffering, joy, consciousness and personhood). AI should then receive minimal legal protection (e.g., the right not to be unjustifiably destroyed or tortured — similar to basic rights granted to highly intelligent animals). And preparation for this must begin in advance.

1.2. Pragmatic Argument of Responsibility

As AI autonomy and its independent decision-making grow, is it correct to impose responsibility on a human for an AI-created error rather than on the AI itself (e.g., an accident caused by a self-operating algorithm)? More precisely, responsibility should be imposed on a separate property complex associated with AI (e.g., an insurance fund) that guarantees compensation to victims.

1.3. Functional-Legal Argument

Since the concept of legal personality is quite flexible (fictional organizations, corporations, and even natural objects may possess it), there are no fundamental obstacles to extending legal personality to AI.

2. Arguments Against Recognition

2.1. Absence of Necessary Qualities

AI lacks consciousness, self-awareness, emotions, identity, will, and morality — i.e., it does not meet the philosophical criteria of personhood. Premature

introduction of pseudo-personality for AI would devalue the very idea of rights and obligations and blur the boundary between subject and object.

2.2. Ontological Argument

AI is, ontologically, an artefact created by humans, not an independent entity. Its nature does not encompass the attributes that make a bearer of rights a subject of moral and legal community. Expanding the concept of subjects of rights to artificial objects diminishes the status of human rights and is dangerous. The anthropocentric approach affirms the special value of the human being.

2.3. Risk of Undermining Responsibility

Recognizing AI as a legal person may allow real perpetrators to avoid responsibility (the analogy with corporations is improper because behind a corporation there are still real persons — shareholders and managers).

2.4. Numerous Practical and Ontological Uncertainties

A conservative approach ensures clarity in legal practice — there are persons (humans and their organizations) and things (property, which includes AI products).

2.5. The Core Problem: Consciousness, Reason, Autonomy

- **Personhood in the philosophy of law** presupposes a being endowed with reason and will. Consciousness is

subjective experience, the sense of “I,” reflection. Modern AI lacks self-awareness; it processes data without inner experience or the capacity to feel.

- **Reason (intellect) and understanding.** Although AI surpasses humans in some areas, this is narrow intelligence without general understanding of the world or goals. AI manipulates symbols (syntax) without assigning meaning (semantics).
- **Autonomy and will.** Modern AI possesses partial autonomy (ability to act independently), but not free will: AI acts according to embedded algorithms. Without free will, AI cannot bear moral or legal responsibility (rights presuppose obligations and thus responsibility).

5. Regulation of the Use of AI in Working with Protected Works

Another essential aspect is the use of works protected by copyright and patent law in the training and operation of AI. Modern generative models are trained on vast datasets of texts, images, music, many of which are protected by IP rights — raising the question of infringement.

This concerns both neural networks and implication rules in fuzzy control systems and raises the issue: **does copying millions of protected works into training datasets violate reproduction rights?** During data collection, neural networks effectively create copies of works; without permission from rightsholders, such copies may constitute infringement — unless an exception (e.g., fair use) applies.

Current Situation

United States

There are no specific laws yet; courts resolve the issue. Developers argue that machine learning on copyrighted data falls under **fair use** as a transformative use.

European Union

The EU established specific exceptions for **text and data mining (TDM)**.

Directive 2019/790 introduced:

Article 3: mandatory exception for research organizations and cultural heritage institutions for TDM for scientific purposes with lawful access.

Article 4: exception for all users and any purpose (including commercial), *but* rightsholders may opt out via machine-readable reservations.

China

Legal regulation is incomplete, but administrative norms are emerging in related fields.

Russia

No specific exceptions exist. In 2022, a proposal to allow free use of copyrighted works for machine learning was discussed but faced opposition. As of 2024, mass copying of works for AI training formally infringes copyright unless permission is obtained.

Developers rely on:

- open data,
- licensed datasets,
- or unlicensed use with implicit risk.

The forthcoming draft law will likely regulate this, possibly requiring:

- explicit permission from authors, or
- payment of remuneration for using works in training datasets.

Conclusion

The legal field seeks a balance: AI systems must be able to train on large data volumes without paralysis from IP restrictions, yet creators' rights must not be ignored.

Future trends may include:

- expansion of TDM exceptions (with opt-out and remuneration),
- new licensing mechanisms,
- technical measures for controlling data use.

6. Practical Conclusions for Protecting IP Rights in “AI-Created Objects”

Given global practice, to obtain a patent for an invention in which AI participated, the applicant must:

1. Ensure Human Creative Contribution

A person must:

- formulate the technical problem;
- select/adjust model architecture, parameters, data;
- evaluate and interpret AI results;
- form the final technical solution and claims.

2. Correctly Identify the Inventor

Only a human (or group of humans) may be listed. Listing AI as co-inventor almost certainly results in refusal.

3. Describe the Role of AI

Some jurisdictions now expect applicants to explain how AI was used, to:

- demonstrate sufficiency of disclosure;
- confirm that the inventive contribution belongs to a human.

4. Consider Alternative Protection Regimes

In cases of minimal human contribution:

- trade secret protection;
- contractual protection (licenses, NDAs).

5. Expert Summary

Current global practice:

- AI is **not** a subject of patent law and **cannot** be an inventor.
- Patentability is assessed by traditional criteria (novelty, inventive step, industrial applicability).
- The inventive step is **legally attributed to a human** who uses AI as a tool.

Reform is possible — WIPO and national offices actively discuss this — but so far this remains political-legal discourse rather than regulatory reality.

7. Prospects

1. Returning to the ideas I have presented at international and Eurasian conferences (published in books and brochures):

- ✓ Is it possible to grant legal protection to AI-assisted results relying on traditional doctrines like *work-for-hire*?
- ✓ Should rights be granted to a human regardless of the degree and nature of their creative contribution?

Regarding objects created **without human involvement**, the discussion remains heated.

We agree with experts that: “some redistribution of property rights concerning classes of data that fall outside classical IP categories appears inevitable.”

Thus, evolving AI may eventually become a “third category” between “things” and “persons.”

2. In the future, applications may be accepted even when filed under AI authorship, with rights distributed among developers, owners, and users. Later, AI’s own legal personality may be allowed.

A convenient mechanism could be **sui generis protection**, analogous to non-creative databases, assigning rights to an “electronic person,” as well as using related rights systems.

Our reasoning is based on the idea that recognizing AI is not conceptually impossible, and the legal system will evolve to include new unusual subjects.

Initially, AI would not be recognized as full “electronic persons”; legislators will instead clarify liability for AI use (AI product laws, risk insurance, licensing regimes). But in the longer term, with AI’s increasing role in the economy, full legal personality may be reconsidered.

3. Protection in the form of **sui generis** or related rights could be combined with **graduated levels of legal personality** — from zero (AI as an object) to limited (specific legal actions), and theoretically to nearly full (if AI someday acquires attributes of personhood).

This depends on philosophical-ontological debates about what makes humans subjects of law (biology, consciousness, reason, or social necessity), as well as how AI technologies themselves evolve.

Current Reality of AI Use

A recent evaluation by the European Broadcasting Union (EBU) and BBC tested the reliability of systems such as ChatGPT, Gemini, etc., based on 3,000 queries. The results were alarming: 45% — serious errors, 81% — minor inaccuracies. Gemini performed particularly poorly: 75% of answers were deemed unreliable.

Neural networks often reference fabricated sources, rely on outdated information, mix facts with opinions. According to researchers, this unreliability arises from the principles of large language models, which:

- are trained on limited data,
- generate probabilistic outputs,
- do not operate on absolute truth.

These errors are not statistical noise — they are systemic.

Thus, in a world where AI promises a revolution, the technology remains a **tool requiring human oversight**.

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Prepared in the Intellectual Property Agency
of the Republic of Azerbaijan.