

LIMITATIONS OF CLASSICAL LOGIC AND CAPABILITIES OF NON-CLASSICAL SYSTEMS FROM THE POINT OF VIEW OF ARTIFICIAL INTELLIGENCE DEVELOPMENT

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Abstract: The article analyzes the differences between classical and non-classical logical concepts. The features and possibilities of transformational logic are considered. Specific details and proposals are analyzed, including using the example of the functioning of ChatGPT, where the use of transformational logic tools, namely rules that clarify the meaning of explicit forms of thought and derive new judgments from explicit forms of thought, as well as complex rules with the help of which it is possible to simultaneously solve the two problems mentioned, would significantly expand the possibilities and improve the operation of artificial intelligence (AI) systems.

Non-classical logical systems, partly critical of classical logic systems, not only open up new prospects for studying thought structures, but also consider issues that go beyond the subject area of classical logical systems, adding the possibilities of logical science.

In terms of interpreting the phenomenon of complementarity of logical concepts, the conception of polylogic by G. Brutian is valuable and the application of his ideas will give positive results from the point of view of further development of artificial intelligence tools.

Keywords: classical and non-classical logic systems, transformational logic, artificial intelligence.

The development of science, from time to time, requires a revision of the methodological tools, their renewal, improvement and development.

Aristotelian logic (Aristotle, 2016), originally intended to serve as methodology of scientific knowledge, has honorably performed this function for centuries, and to a large extent still underlies the methodology of science.

Nevertheless, it has gone through interesting stages of development and improvement.

The processes of review and improvement of Aristotelian logic began in the time of F. Bacon, when the rapid development of experimental science formulated the need to develop a new method for collecting and systematizing experimental data. Bacon's "New Organon" (Bacon,

1620) developed and enriched classical logic in the spirit of empiricism and inductivism.

Thomas Hobbes made a significant contribution to the development of Aristotle's classical logic. The first section ("Calculus and Logic") of the first part of his work "Fundamentals of Philosophy" he devoted to the analysis of logical problems and developed the idea that the process of thought can be formulated to mathematical operations. Like numbers, one can add and subtract concepts, judgments, thoughts, facts, laws, etc. And logic should study arithmetic operations in relation to concepts, judgments, syllogisms (Hobbes, 1989, pp. 73-138).

The contribution of René Descartes ("Rules for the Guidance of the Mind" (Descartes, 1953a) and his followers Antoine Arnauld and Pierre Nicole's ("Port-Royal Logic", 1996) is undeniable.

The role of Gottfried Leibniz in the mathematization of mental operations and the formulation of a sufficient fundamental law is especially important (Leibniz, 1948, p. 235).

Of particular importance in the process of development of classical logic systems was the formation and development of mathematical (formalized) logic – propositional logic, predicate logic and classes.

Nevertheless, the 1780s can be considered a kind of "start" of the process of critical examination of the foundations of traditional Aristotelian logic, and this process is associated with the name of Immanuel Kant.

Although Immanuel Kant in his work "The Critique of Pure Reason" (1787, Preface to the Second Edition), speaking about Aristotelian logic, notes that "since the time of Aristotle it has not had to take a step back ..., nor a step forward, and, apparently, it seems to be a completely finished and complete science" (Kant, 1787). However, in the same work, Kant, criticizing Aristotelian logic, calls it formal, which "abstracts from any content of knowledge, i.e. from any relation to the object, and considers only the logical form in the relation of knowledge to each other, i.e. the form of thinking in general" (Kant, 1787, 2-nd part, II.). In return, he proposes transcendental logic, which, when considering the forms of thinking, also considers the nature of the object of knowledge, the origin and objective meaning of the knowledge embedded in the forms of thought.

G. Hegel proposed the concept of **dialectical logic**, where, in contradistinction to formal logic, which considered forms of thought from the point of view of quantitative and volumetric characteristics, the components of thought are characterized based on their cognitive content, the role they play in the process of cognition (Hegel, 2010, pp. 506-734).

All of the listed stages of development of logical science, with the exception of transcendental and dialectical logic, can be attributed to the history of the development of classical logic.

Non-classical concepts in logical science, in fact, began to rapidly form and develop from the first half of the 20th century.

How do non-classical logical concepts differ from classical logic?

Classical logic is based on two important principles.

The principle of bivalence, according to which each judgment (statement) can take only two values of truth: be true or false.

The principle of functionality (existentialism), according to which the truth of a complex judgment (statement) is (conditioned, dependent) on the truth values of the constituent simple judgments and the functional significance of the logical connections that make up the complex judgment.

There are several approaches to the classification of non-classical logic in the scientific literature. Thus, Susan Haack in her work "Deviant Logic: Some Philosophical Issues" divides all non-classical logics into **deviant, quasi-deviant and extended logic**, while a logical system can be both deviant and an extension of classical logic (Haack, 1974, pp. 1-24).

Other authors highlight deviation from the basic principles of classical logic and extension, that is, **consideration of issues that remain outside the subject area of classical logic**, as the main difference between non-classical logic.

Princeton University professor J. Burgess uses a similar classification of logics, identifying two main groups: **anti-classical and extra-classical** (Burgess, 2009, pp. 1-2).

Non-classical concepts of logic include multi-valued logic, systems of strict implication, constructive, modal and interrogative logic.

In 1983, the Armenian philosopher G. Brutyan developed another interesting concept of

non-classical logic - **transformational logic, which can be attributed to a number of “extended” logics** (Brutian, 1983).

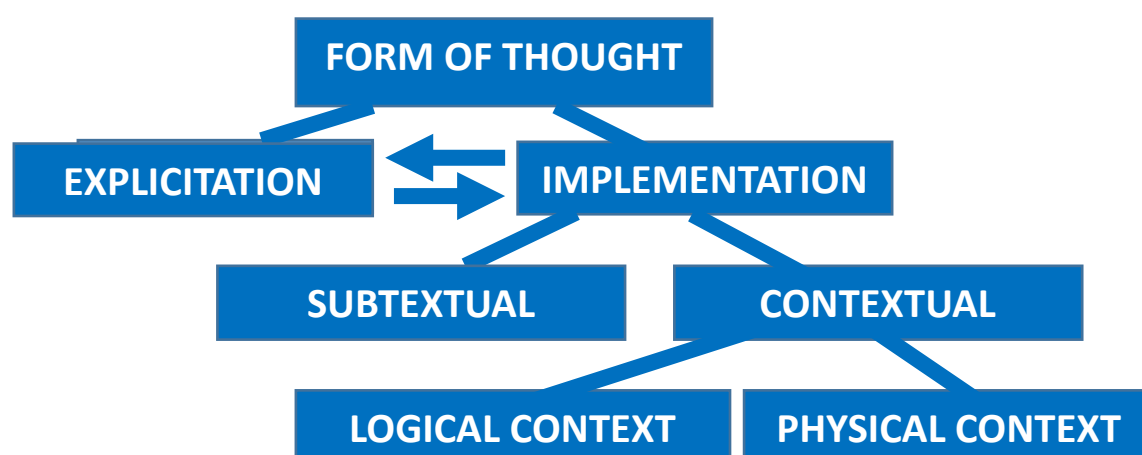
It studies the relationship between explicit (evident) and implicit (inedvident) forms of thought, the laws of inference from explicit to implicit forms of thought, as well as the principles of clarifying the meaning and significance of explicit forms of thought using the analysis of implicit forms.

Explicit is form of thought is one that is recorded by linguistic means (written or oral speech units) and perceived by the senses of the

interlocutor.

Implicit is a form of thought that is not expressed by linguistic means (external, conversational-subjective speech units) and is not perceived by the senses, but can be inferred, it can be guessed as a result of analyzing the context and subtext of a given text. Accordingly, implicit forms of thinking are **subtextual and contextual, and the latter can be physical and logical**.

Scheme 1: Classification of forms of thought in transformational logic.



Context is a system of reasoning (**logical context**) within which a given statement (thought or expression) is used, or the conditions and circumstances, such as the educational level of the audience, demographic composition, circumstances of the case, political situation, etc. (physical context), under which a speech is presented, a sentence or idea is considered.

Subtext is a system of judgments that, although not clearly fixed by means of linguistic units of the text, can be deduced and guessed as a result of additional analysis of the judgments of the text. For example, fables, which are often allegorical short stories, usually end with a short moralistic message-conclusion: “What the fable tells about ...”, which is the main meaning of the work.

G. Brutian divides the rules of transformational logic into three groups: **rules of generation (elucidation), rules of precision and complex rules** (Brutian, 1983, pp. 51-57; 76).

The rules of generation are logical methods by which implicit forms are derived from explicit forms of thought.

These are the rules of conversion, obversion and contraposition of a simple attributive judgment.

For example, as a result of the conversion of the general affirmative judgment “*Man is a rational being*”, we obtain the particular affirmative judgment “*Some rational beings are people*”. Additional analysis of this conclusion gives grounds to assume: “*It is possible that in addition to man, there are other rational beings, for example, God, representatives of an extra-terrestrial civilization, etc.*”

The tools of transformational logic significantly expand the capabilities of traditional formal logic, allowing us to make more accurate conclusions. For example, the judgment “*Some people are violinists*” in the system of formal logic is converted in a simple way: $(S \text{ i } P) \rightarrow (P \text{ i } S)$ “*Some violinists are people*”. However, taking into account the factor of the ratio of the volumes S and P, we can derive a more accurate - general affirmative judgment: “*All violinists are people*”.

It is known that a particular negative judgment

ment is not subject to conversion in traditional formal logic. Otherwise, if we are guided by the principle of distribution of terms, which underlies the rules of conversion, then the judgment “*Some people are politicians*” will lead to the absurd judgment “*No politician is a person*”. Meanwhile, within the framework of transformational logic, taking into account the content of the relationship by volume **S** and **P**, we can conclude: “*All politicians are people*”.

One of the well-known logical proofs of the existence of God is based on the principle of identifying and analyzing the subtextual content of concepts and judgments: “In the course of his cognitive activity, a person constantly questions his impressions and knowledge, checks and rechecks and tries to improve them. And if a person doubts and strives to develop, then he is imperfect. A judgment about imperfection can only make sense in comparison with perfection. Therefore, perfection exists by necessity. However, it is not perceived by the senses and does not exist in nature. Therefore, it is supernatural. Therefore, this is nothing other than the idea of God himself, from which the conclusion about the existence of God follows.” The course of such reasoning is defended and a similar argumentation about the existence of God is offered, for example, by R. Descartes in his “Discourse on Method” (Descartes, 1953b, pp. 51-53).

Rules of precision are those that clarify the meaning and significance of the form of thought under consideration.

Analysis of the context allows you to clarify the meaning and significance of an expression or judgment. Without taking into account the logical or physical context, it is impossible to unambiguously interpret the meaning of the following judgments. “John said to Ben: “What a robber you are!””, “Gevorgyan was always proud of this operation”, “The lecturer was pleased with the audience”. If John’s statement to Ben was made during a trial or a domestic quarrel, it would be interpreted as an insult and a remark. But if this statement was made when Ben organized an unexpected meeting with a pleasant person for John, then the mentioned words should be understood as a compliment. In the second example, depending on the situation, the phrase “operation” can mean surgical intervention, military, financial, intelligence or counter-terrorism action. The true meaning of the third

judgment can also be clarified only by clarifying the logical or physical context.

Complex rules are those that allow you to simultaneously derive implicit judgments and clarify the meaning and significance of the explicit form of thought under consideration. Consider the following anecdote. A Georgian, having learned that Tigran Petrosyan has won the title of world chess champion, tells his friend the news:

- You know, the Armenians have won the title of World Chess Champion.

- Seriously?, all of them? - the interlocutor naively asks.

In order to determine whether the judgment “the Armenians have won the title of World Chess Champion” is in fact general, particular, or singular, it should be associated with quantifiers of generality (“all”, “each”), existence (“some”), or uniqueness (“one”, “the only”). As a result, the meaning of the judgment will be clarified and a more precise, unambiguous affirmative judgment will be derived that “one of the representatives of the Armenian people has won the title of World Chess Champion.”

It is impossible in principle to limit the process of identifying implicit forms of thought from explicit ones. The number of layers that are revealed and the number of implicit thoughts are determined by the stock of knowledge of the interpreter, by the knowledge that he compares with the judgments under consideration. Therefore, the classification of generative, precisiv and complex rules has, in a certain sense, a relatively conditional character, since in the case of a generative rule, an additional result can be a clarification of the meaning of thinking, and when clarifying one thought, the derivation of new, additional judgments.

The operational field of transformational logic is quite broad and covers all areas of mental activity: interpersonal communication, negotiations, mass media, advertising, politics and enrichment of the methodological and hermeneutic tools of particular sciences (law, sociology, psychology) (Hovhannisyan, 2008, pp. 617-626).

The currently gaining popularity tools of artificial intelligence, mainly based on classical logical systems, in some cases also experience

difficulties with the correct answer to the tasks set. The author of this article was convinced of this when he worked on a university manual on logical exercises and practical tasks in 2024.

Let's consider several examples that cannot be solved using only traditional classical logic. However, difficulties are overcome when using the tools of transformational logic.

Example 1. Task proposed to ChatGPT (22.10.2024):

Determine the composition of this syllogism, identifying the minor, major and middle terms, the major and minor premises. Show the relationships between the terms and comment on the logical correctness.

“Jews are intelligent people. Hans is a Jew. Therefore, Hans is smart.”

Answer from ChatGPT:

“This example presents a categorical syllogism. Let's analyze its composition, identifying the minor, major and middle terms, as well as the major and minor premises:

1. Major term (predicate of the conclusion): “smart”. This is a characteristic that applies to the subject of the conclusion.

2. Minor term (subject of the conclusion): “Hans”. This is the specific object that is discussed in the conclusion.

3. Middle term: “Jew”. This term connects the minor and major terms through the premises.

Now let's highlight the premises:

- **Major premise:** “Jews are intelligent people” (All Jews are intelligent).

- **Minor premise:** “Hans is a Jew” (Hans belongs to the category of Jews).

- **Conclusion:** “Hans is intelligent”.

Relationships between terms:

- The middle term (“Jew”) connects the major term (“smart”) with the minor term (“Hans”). The logic of the reasoning is that if all Jews are intelligent (major premise), and Hans is a Jew (minor premise), then Hans must also be intelligent.

Logical correctness:

This syllogism is **formally correct** since it corresponds to the structure of a correct categorical syllogism: the middle term is in the premises, but not in the conclusion; the minor term is connected to the major term through the middle. However, in this case, it can be noted that:

1. The major premise (“Jews are intelligent

people”) is a generalization that can be controversial and not precise enough since it attributes a characteristic to an entire group of people.

2. The logical form of the syllogism is correct, but the truth of the conclusion depends on the truth of the premises.”

Note: However, if we resort to the tools of transformational logic, we can see that the major premise is not a **general**, but a **particular affirmative judgment**.

This can be verified by combining this judgment with the universal and existential quantifiers. When combining a judgment with a universal quantifier (when placing the words “each” or “every” before the subject), a false judgment is obtained. When combined with an existential quantifier, the proposition becomes true.

Therefore, the major premise of this syllogism is not a general affirmative proposition, but a particular affirmative proposition.

This means that this conclusion belongs to the 1st figure of the syllogism and has the following formula: $((M - i P -) \& (S + a M -)) \rightarrow (S + a P -)$. Two rules of syllogism are violated: a) “M” is not distributed in any premise and b) the major premise is not a general judgment.

However, ChatGPT learns and develops quickly.

Example 3. On July 3, 2024, ChatGPT was given the following task:

Analyze this syllogism, showing the major, middle, and minor terms. Show the relationships between the terms schematically. Justify the logical correctness or incorrectness of the conclusion.

“It is impossible to read all of Pushkin's works in one day. “The Tempest” is one of Pushkin's works. Therefore, it is impossible to read “The Tempest” in one day.”

Answer from ChatGPT:

“Let's analyze this syllogism by defining the major, middle, and minor terms, and the relationships between them.

Terms:

1. Major Term: Read in one day (X).

2. Middle Term: The works of Pushkin (Y).

3. Minor Term: “The Tempest” (Z).

Syllogism Structure:

A syllogism consists of two premises and a conclusion:

1. Major Premise: It is impossible to read all

of Pushkin's (Y) works in one day (X).

2. Minor Premise: "The Tempest" (Z) is one of Pushkin's (Y) works.

3. Conclusion: Therefore, it is impossible to read "The Tempest" (Z) in one day (X).

Scheme of relations between terms:

1. All Y's are not X.
2. $Z \subseteq Y$.
3. Therefore, $Z \rightarrow \text{not } X$.

All Y (Pushkin's works) cannot be X (read in one day). Z ("The Tempest") $\subseteq$ Y. Therefore, Z cannot be X.

Logical correctness:

In order to determine the logical correctness of this inference, it is necessary to consider the forms and rules of the syllogism:

1. Form of the syllogism: This syllogism is a form of the Barbarian syllogism (AAA-1)¹, which has the form:

- All A's are B.
- All C's are A.
- Therefore, all C is B.

2. Application to our case:

- All of Pushkin's works (A) cannot be read in one day (B).
- "The Tempest" (C) is a work of Pushkin (A).
- Therefore, "The Tempest" (C) cannot be read in one day (B).

There are no logical errors in this syllogism. It is correct because both terms are included in the corresponding classes correctly and the conclusion follows logically from the premises.

Thus, this syllogism is logically correct.

The logical correctness of the inference is justified by the fact that it corresponds to the form of the categorical syllogism modus Barbara (AAA), where both premises are statements of generality, and the conclusion is also a statement of generality. This inference is logically correct because if all elements of the middle term (Pushkin's works) have the property of a large term (it is impossible to read in one day), and the smaller term ("The Tempest") is part of the middle term (is one of Pushkin's works), then the smaller term also has the property of a large term. Thus, the conclusion follows logically from the premises."

¹ It should be noted that it would be more correct to consider this reasoning as the Celarent modus of the 1st figure of the syllogism. Although this does not change the final conclusion much.

The same task was proposed by ChatGPT about four months later, on 22.10.2024.

The answer turned out to be relatively correct – with a cautious caveat:

"Let's analyze this syllogism, identify its terms, analyze the relationships between them and evaluate its logical correctness..."

Syllogism formula:

1. Major premise: All A (Pushkin's works) are B (impossible to read in one day).

2. Minor premise: C ("The Tempest") is part of A (Pushkin's works).

3. Conclusion: Therefore, C ("The Tempest") is B (it is impossible to read in one day).

The relationship between the terms can be represented as follows:

$C \subseteq A$ and $A \subseteq B \Rightarrow C \subseteq B$

Here the conclusion is made that if "The Tempest" belongs to the set of Pushkin's works, and all of Pushkin's works cannot be read in one day, then "The Tempest" cannot be read in one day.

Logical correctness:

1. Formal correctness: The syllogism is formally incorrect because it violates the rule of transition from the general to the particular. The major premise says that all of Pushkin's works as a whole cannot be read in one day. However, this does not mean that individual works (for example, "The Tempest") cannot be read in one day either. The syllogism makes the incorrect assumption that the properties of the whole automatically apply to its parts.

2. Material correctness: The major premise concerns all of Pushkin's works as a collection, not their individual characteristics. Perhaps individual works (for example, "The Tempest") are short enough to be read in one day, in spite of the fact that the entire frame of works requires more time. The conclusion is incorrect since it does not follow from the premise.

Conclusion: This syllogism is logically incorrect in both the formal and material sense. The error lies in the incorrect transition from the general property of the set (Pushkin's works as a whole) to the particular (one work)".

Note: Again, if we use the rules of transformational logic, we can reveal that in the major premise M ("Pushkin's works") is a general collective concept. We are talking about all of Pushkin's works taken together. And in the

minor premise, only one particular work is discussed. The relationship between the whole and the part is confused with the generic relationship between concepts. The relationship between the **whole** and the **part** is confused with the **generic-specific relationship between concepts**.

After such clarification, we can already switch to the “language” of classical logic and show that in this syllogism an error of *quadrupling terms* was made (when four terms were used in the syllogism instead of three).

Example 3. Task for ChatGPT:

Represent the syllogism as a formula, determine the figure and comment on the question of logical correctness.

“Man conquers the Universe and extracts energy from the nucleus of the atom. Gavrila is a man. Therefore, Gavrila conquers space and extracts energy from the nucleus of the atom.”

Answer from ChatGPT (22.10.2024):

“Let’s represent this syllogism as a formula and determine its figure:

Syllogism:

1. Major premise: Man conquers the Universe and extracts energy from the nucleus of the atom.

2. Minor premise: Gavrila is a man.

3. Conclusion: Therefore, Gavrila conquers the Universe and extracts energy from the nucleus of the atom.

Syllogism formula:

• **Major premise:** All A (men) are B (those who conquer the Universe and extract energy from the nucleus of the atom).

• **Minor premise:** C (Gavrila) is A (man).

• **Conclusion:** therefore, C (Gavrila) is B (conqueror of the Universe and extractor of energy from the nucleus of an atom).

Definition of a figure:

This syllogism has the 1st figure, because the middle term (“man”) in the major premise is the subject, and in the minor premise it is the predicate. The formal structure of the first figure is as follows:

1. All A are B.

2. C is A.

3. Therefore, C is B.

Logical correctness:

• **Formal correctness:** The syllogism is formally correct. It corresponds to the structure

of the first figure of a categorical syllogism. The middle term (“man”) connects the minor term (“Gavrila”) with the major term (“conquers the Universe and extracts energy from the nucleus of an atom”).

• **Material correctness:** The problem is in the content (material correctness). The major premise (“Man conquers the Universe and extracts energy from the nucleus of an atom”) is indeed an overly broad generalization. In reality, not every person has such abilities - this is more likely to be applied to a group of scientists or researchers. Thus, the major premise is false or insufficiently substantiated, which makes the conclusion incorrect in terms of content.

• **Conclusion:** Although the syllogism is formally correct, its material correctness is still questionable. Not all people conquer space and extract energy from the atomic nucleus, so the conclusion cannot be true.”

Note: At first glance, it seems that we are dealing with the 1st figure of the syllogism, the Barbara mode: $((M+ a P-) \& (S+ a M-)) \rightarrow (S+ a P-)$

However, using the rules of clarification of transformational logic once more, we can find out that the major premise is **not a general affirmative judgment**, but a **particular affirmative judgment instead**.

Therefore, the syllogism actually has the **following formula:**

$((M- i P-) \& (S+ a M-)) \rightarrow (S+ a P-)$.

Here classical logic comes into play, with the help of which we can find out that, as in the first example, two errors of syllogism have been made:

a) “M” is not distributed in any premise,

b) the major premise is not a general judgment.

Conclusion

Thus, non-classical logical concepts, partly critical of the systems of classical logic, simultaneously complement and expand their capabilities, stimulating a new phase in the development of logical science.

From this point of view, the principle of polylogic (Conception of Polylogic) of Academician G. Brutyan (1968) is valuable.

This concept is the idea of deepening and

revealing new semantic and structural layers of the thinking process by analyzing and evaluating the forms of thought from the point of view of various logical systems and tools.

According to this concept, formal logic and systems of substantive logic do not so much contradict each other as complement each other, and formalized (mathematical) logical systems (“mathematics of consciousness”) play the role of a kind of explication in terms of clarifying the thought structures studied by formal logic (“grammar of mind”).

By reconsidering the traditional principles of bivalence and functionality, non-classical logical systems not only open up new prospects for the study of logical structures but also consider issues that go beyond the subject area of classical logical systems, enriching knowledge and expanding the possibilities of analyzing and evaluating thinking structures. The principle of mutual complementarity and, in particular, the possibilities of transformational logic seem valuable for the further development of artificial intelligence systems and tools.

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