Formalizing Meaning and Knowledge for AGI Development

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June 5, 2024

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Abstract

Artificial General Intelligence (AGI) is different from specialized Artificial Intelligence (AI) in that it can understand and work with meanings, mimicking human mental processes. Existing AI platforms are not aware of the significance of the things they interact with unlike deep chess or facial recognition systems. They rely on statistical patterns instead of semantic understanding and hence perform narrow tasks well rather than grasping higher level concepts.A very essential task today is defining meaning. Thus, this paper outlines a roadmap aimed at formalizing the notions of knowledge and meaning in such a manner that may facilitate their incorporation into AGI. Today's definitions are not good enough because they are not strict or machine-friendly. Consequently, we suggest a systematic an(AP) approach which should be used to describe what we mean with mondo e sense making (or rather enc "oding"), c term s that will be introduced below.. The proposed approach aims to bridge the gap between human cognitive capabilities and artificial systems, advancing the field towards the realization of true AGI.

Keywords: meaning, knowledge, existence, perception

1 Introduction

The quest for Artificial General Intelligence (AGI) represents one of the most ambitious and transformative challenges in the field of artificial intelligence. Unlike narrow AI systems, which are designed to perform specific tasks with high efficiency, AGI aspires to replicate the broad, flexible, and adaptive intelligence observed in human beings. A defining characteristic of AGI is its ability to understand and manipulate meanings, allowing it to process and interact with information in a contextually aware and semantically rich manner. This capability is crucial for AGI to emulate human cognitive processes and engage in a wide range of intellectual tasks.

Currently, AI systems have achieved remarkable success in various specialized domains. They have mastered complex games like chess and Go, driven vehicles autonomously, and achieved high accuracy in facial recognition and natural language processing. However, these systems operate fundamentally differently from human intelligence. They rely heavily on pattern recognition, statistical analysis, and extensive training data, without any intrinsic understanding of the semantics or meanings behind the data they process. This limitation highlights the significant gap between current AI capabilities and the aspirations of AGI.

To bridge this gap, it is essential to formalize the concepts of "meaning" and "knowledge" in a manner that is both rigorous and programmable. Traditional definitions of these concepts often lack the precision required for computational implementation, making them unsuitable for the development of AGI. This paper aims to address this critical challenge by proposing a structured methodology for defining and encoding meanings. By formalizing these concepts, we can create a foundation for AGI systems to process information in a way that is contextually aware and semantically meaningful.

In this paper, we will review the existing approaches to defining meaning and knowledge, highlighting their limitations in the context of AGI. We will then present a novel framework for formalizing these concepts, emphasizing their programmability and applicability to AGI development. Our proposed approach seeks to advance the field of artificial intelligence by providing the necessary tools to build systems capable of genuine understanding and cognitive emulation, moving us closer to the realization of true AGI. [1] [2] [3] [4] [5] [6] [7] [8][9]

2 Fundamental definition

An element is said to exist when it is a part of a set. This is a common, fundamental definition. After that, we expand on this definition and make several deductions.

2.1 Recursiveness in Defining Existence

The strength of this definition lies in its recursive nature. The concept of a set inherently includes its role as an element within another set. This recursive application helps us comprehend and describe the complexity and diversity of various forms of existence.

2.2 Defining "What" and "Where"

When attempting to establish the existence of something, it is essential to identify two entities: "what exists" (the element) and "where it exists" (the area or set to which this element belongs). This can also extend to "when" it exists, and for immaterial entities, even "how" it exists.

2.3 The Criterion of Existence: Undefined, Exists, and Does Not Exist

Beyond the values of "exists" and "does not exist," there is an initial value of "undefined" in the criterion of existence. This value signifies the subjectivity of the concept of existence. "Undefined" essentially means "unknown" to an observer who is attempting to determine existence.

3 Conceptual Interpretation of Existence within Areas

It is intuitively understandable that for material objects, existence is confined to a specific area of space that encompasses them. Being "inside" means that an object exists within that area. Conversely, it does not exist in another area if these areas do not interact in any way. This concept can be defined recursively: if two areas of space (defined as sets) do not belong to any other area, then the objects within one area do not exist for the other. This interpretation applies not only to material objects but also universally to sets and elements. The set is the most general entity that can include its constituent parts, or elements. Space, territory, region, and even the Universe are less general entities since even the Universe can be an element in the set of all Universes. Furthermore, the concept of existence and the areas of existence can extend beyond physical space to include immaterial and virtual entities, such as the parameters of a system and the range of their possible values.

3.1 Alternative Interpretation of Existence within Defined Areas

Spatial Confinement and Interaction

Material objects exist within a specific spatial area that defines their presence. An object is said to exist for a particular area if it is contained within it. If two spatial areas do not interact or overlap, the objects within one area do not exist for the other. This recursive definition applies to any nested spatial areas, ensuring that the existence of objects is confined to the areas they occupy and interact with.

Sets and Elements as Universal Constructs

In a universal sense, the concepts of "set" and "element" provide a foundational framework for understanding existence. A set is the most general entity capable of containing its elements. In this context, space, territory, region, and even the Universe are specific instances of sets. The Universe itself can be an element within the set of all possible Universes, demonstrating the hierarchical nature of sets and elements.

Extending Beyond Physical Space

The notion of existence and the areas in which entities exist can also encompass immaterial and virtual realms. For example, the parameters defining the functioning of a system and their possible values can be viewed as sets and elements within a non-physical space. This broader interpretation allows for the inclusion of abstract and virtual entities, expanding the concept of existence beyond mere physicality.

In this alternative interpretation, the interplay between sets and elements, physical and immaterial spaces, and the recursive nature of defining existence within areas provide a comprehensive understanding of how entities are confined and interact within their respective domains.

4 Definition and Explanation

1. Relation: • Definition: An interaction or connection of any kind between the elements of a set.

• Implication: The existence of a relation between two elements implies that these elements are connected in some manner, making them observable or perceivable to each other.

2. Elements Without Relations:

• Definition: If two elements in a set are not connected by any relation, they exist independently.

• Characteristics: These elements are not perceived by each other. They are not observable, tangible, or measurable to one another.

3. Perceived Elements: • Definition: When a relation exists between elements, they are perceived by each other.

• Types of Perception:

• Unidirectional: One element perceives the other, but not vice versa.

• Bidirectional: Both elements perceive each other.

4. Illustration with a Disjoint Directed Graph:

• Concept: A disjoint directed graph can represent the existence (or absence) of relations in a set. Nodes represent elements, and directed edges represent the presence and direction of perception or relation.

5. Physical Meaning and

Examples

• **Example 1**

A man (element) sees an apple (element) in a garden (set). The apple existed before being seen. After the man sees it, a relation forms, making the apple perceived. • **Example 2**

The square root of 2 exists in the set of real numbers. The existence of such mathematical concepts depends on the existence of the set they belong to.

• **Example 3**

The beauty of art exists for the perceiver. The relation of preference makes it perceived.

• **Example 4**

A tractor (element) in a field (set) is perceived by the tractor driver (element) but not by other workers until they see it. Its existence and perception vary for different observers. Implications

1. Existence and Perception

• Existence alone does not imply perception. An element can exist without being perceived if there is no relation to other elements in the set.

2. Context-Dependent Perception

• Perception is context-dependent and varies based on the observer's relation to the element. What is perceived by one element may not be perceived by another.

3. Subjectivity and Objectivity

• This framework accommodates both objective existence (elements exist regardless of perception) and subjective perception (elements are perceived differently by different observers). Applications

1. Scientific Observations

• Understanding phenomena through the relations between observable entities and instruments.

2. Philosophy and Epistemology

• Exploring the nature of reality and knowledge based on relations and perception.

3. Mathematics and Logic

• Utilizing sets and relations to define existence and properties of mathematical objects. Summary This conceptual framework provides a nuanced view of existence and perception. It highlights that the presence of a relation between elements is crucial for perception, and that perception can be directional and subjective, depending on the observer's context within the set.

5 The Paradoxical Nature of Existence and Observation

Due to the set-theoretic nature and recursiveness of the proposed basic definition of existence, it admits paradoxes. It is also interesting to note that for some elements, the fact of existence can be determined by creating a relationship that removes (destroys, changes) an element from the set. That is, it is possible to determine that an element exists (to measure it) only by removing (destroying, changing) it. This is known to be observed in quantum physics. In the macrocosm, any observation (the implementation of a relationship) also changes both the observed object and the observer, it's just that such changes may be recognized as insignificant, but they always exist.

The notion of existence intertwined with observation is a cornerstone of both philosophical and scientific discourse. The recursive and paradoxical nature of existence definitions, especially within set theory, challenges our understanding of what it means to "exist." When we delve into quantum physics, the act of measurement itself becomes a transformative event, wherein the observed element's state is altered or destroyed, affirming its existence through this very act of change. This phenomenon, famously illustrated by the Heisenberg Uncertainty Principle and the observer effect, reveals the delicate interplay between existence and observation at the quantum level.

In the realm of the macrocosm, the principles hold true, albeit less dramatically. Any act of observation inherently modifies the state of both the observer and the observed. While these changes are often negligible and can be easily overlooked, they underscore a fundamental truth: interaction and relationship are essential to the concept of existence. This interplay prompts a reevaluation of how we perceive reality and existence, urging us to consider the implications of every act of observation and its transformative power.

6 The Perception and Confirmation of Existence through Relations

The perception of existence between two elements within a set is fundamentally influenced by the relational dynamics between them. When a relation exists, one element perceives the other, thereby affirming its existence. In scenarios where this relation is unidirectional, only one element's existence is affirmed. For instance, a soap advertisement featuring an artist captures the existence of both the artist and the soap for the audience. However, the artist (and the soap) remain unaware of the existence of the individual viewers.

This relational concept can also be introspective. An object can affirm its own existence through self-relation. René Descartes' famous dictum "Cogito, ergo sum" ("I think, therefore I am") exemplifies this notion. Descartes' statement highlights that any self-referential assertion is inherently a relation, thereby confirming the object's existence to itself. This form of self-relation is valid but limited to entities capable of thought.

However, the scope of Descartes' assertion is partial. It applies specifically to thinking beings, yet the converse, such as "I do not think, therefore I exist," can also hold true. Existence is not solely contingent upon thought. For example, the character Groot from the Guardians of the Galaxy series, who repetitively says, "I am Groot," confirms his existence to himself and others through this simple phrase. The statement "I am" itself constitutes a relation, thereby affirming and perceiving one's own existence.

7 Redefining Perception, Data, Meaning, and Knowledge

Perception Definition: Perception is the projection or realization of a connection (result of interaction) between elements of a set onto an object. Datum Definition: A datum is any representation (such as a description or machine view) of a single element of perception. It is the elementary result of the interaction of objects, captured in any representational form.

Data

Definition

Data is a collection of datums (datasets). Any selection of datums forms data.

Meaning

Definition

Meaning is a representation (such as awareness, description, formula, algorithm, or program code) of a single act of relation. It embodies the mechanism of interaction between objects as a whole, rather than just the result of such interaction. This interaction can be seen as an integral and complete act, despite potential complexity from recursive interactions. Sense and Interaction Based on these definitions, the question "does it make sense?" assesses whether an intended action (a single act of relation) fits within a holistic interaction of objects. An action makes sense if it aligns with a correct interaction, like employees collaborating toward a group goal; it doesn't if it fails to belong to the set of correct actions. Intelligence

Definition

Intelligence is an operator of meanings. It is the ability to handle meanings, forming and creating them, thereby discovering relationships between elements of various sets, environmental objects, or virtual entities. Knowledge

Definition

Knowledge is a set of meanings, representing relationships or interactions between objects. It encompasses any representation (awareness, description, formula, algorithm, program code) of a relationship as a whole or any subset thereof. Data, on the other hand, is the representation of the perception of the results of these interactions.

Example:The Number π

The Number π

• Existence: The number πbelongs to the set of real numbers and thus exists as part of that set.

• Relation: The definition of πestablishes its relationship with other real numbers.

• Knowledge: Any formula for calculating π constitutes knowledge.

• Meaning: A formula for determining any digit of π is the meaning.

• Datum: A calculated decimal place of π (or its approximation) is a datum.

• Data: A subset of decimal places of π constitutes data.

Remark on Information and Uncertainty

While data is information, we do not delve into its connection with Information Theory here. However, both data and knowledge relate to levels of uncertainty, or Shannon entropy. Information Theory treats this uncertainty objectively within a strictly defined abstract area. In our interpretation, the objectivity, materiality, and very existence of any value depend directly on the context in which it is defined.

8 Understanding Systems Through Perception of Diversity

Defining a System

A system is an object characterized by diversity. The term "object" implies that the system can be isolated from its surroundings through perception. "Diversity" indicates that the system possesses a discernible structure — attributes, behaviors, elements, etc.

Material Objects as Systems

Any material object, such as a stone, table, or apple, becomes a system when we recognize any form of diversity within them. This diversity can be in the form of ontology elements, attributes, categories, or properties like color, smell, or other physical parameters.

Intangible Objects and Systems

Intangible objects follow the same principle. For instance, the text of Leo Tolstoy's "War and Peace" or Shostakovich's symphony may appear monotonous to someone who doesn't perceive their diversity. To such an observer, these works are not systems but rather information noise or sound noise. However, for someone who understands the structure, meaning, or harmony within these works, they indeed constitute systems.

Perception and Diversity

The recognition of an object as a system hinges on the perception of its inherent diversity, which can also be referred to as complexity, structure, properties, or connections. The term "diversity" serves as a broad descriptor. It does not matter if the object is static or dynamic; an entity is not considered a system until it is perceived as having structure, connections, or behavior.

The Role of Perception in Defining Systems

Consider a dynamic object like an apple falling from a tree. For most people, this event is merely a dynamic occurrence. However, for Newton, who perceived a set of connections and properties associated with the apple, it represented a system. This illustrates that an object qualifies as a system based on the observer's ability to perceive its diversity and structure.

9 Abduction vs. Deduction in Scientific Reasoning

Sherlock Holmes and Abduction

Contrary to popular belief, Sherlock Holmes practised abduction, not deduction (Carson, D. 2009). This approach involves forming a hypothesis that an element belongs to a certain set based on a shared property among the elements. Unlike deduction, which proves that something must be, and induction, which shows that something actually is operative, abduction merely suggests that something may be (Peirce, 1934).

Understanding Abduction

Abduction is a generalization procedure. It creates a representation of a set based on known data about its elements. The presence of a common property among elements suggests, but does not prove, that an element belongs to the set or that the set exists. This assumption can be iteratively tested to verify its validity. The common property signifies a relation within our broader definition, representing a search for meanings or elements of knowledge.

Peirce's Contribution to Abduction

Charles Peirce, who coined the term "abduction," viewed it as a mechanism for generating scientific hypotheses. He posited that while induction and deduction are vital to science, only abduction can originate new ideas (Peirce, 1934).

Application of Abduction in AGI Development By utilizing a set-theoretic approach to existence and perception, we can formalize the process of abduction. This formalization can potentially be applied to the development of Artificial General Intelligence (AGI), enabling machines to search for meanings and generate new hypotheses through consecutive applications of abduction.

10 The Role of Logical Reasoning in AGI Operating in Natural Language

Abduction, Deduction, and Induction are crucial methodologies for AGI, especially in the realms of generalization and the formation of meaning. While abduction is pivotal for hypothesizing and creating generalized insights, deduction and induction are essential for forming logical conclusions and manipulating logical statements. In this context, we are focusing on AGI in a narrower sense—specifically, an artificial intelligence capable of operating within natural language.

10.1 Aristotle's Syllogisms and AGI

The systematization of logical statements began with Aristotle, whose syllogisms represent a collection of verbal formulations that encapsulate the principles of binary logic in natural language. Despite the advanced state of binary (Boolean) logic, which includes set-theoretic operations, our interest lies in implementing logical statements in natural language. Aristotle's syllogisms are particularly promising for developing an AGI logic processor. This processor would serve as the mechanism for constructing reasoning, deriving logical conclusions, and establishing cause-and-effect relationships within natural language texts.

11 Simplified AGI Logic Processor: An Overview

In natural language, AGI should operate with relations expressed by sentences containing logical statements. The truth of these logical statements is verified by sentences containing information, the truth of which does not need to be proved. There is a limited number of types of possible syllogisms and declarative sentence structures. Hence, the "AGI logical processor" must operate with only a limited number of inference patterns.

This conclusion is crucial because it suggests that a highly complex and intelligent AGI can result from the recursion of a simple basic model. This model operates with simple logical statements, initially equipped with a minimal set of such "patterns of meaning."

11.1 Adding Abduction Patterns

Incorporating the "abduction pattern" into the "AGI logic processor" allows it to build relations that generalize existing information in its knowledge base. Essentially, this means the basic version of AGI doesn't need to create new, previously unknown relations but rather test hypotheses posed by humans during dialogues with AGI.

12 Example: Relation Verification Using Abductive Reasoning

Question (Hypothesis)

"Have people been to the Moon?" Data (Information Stored in the Knowledge Base):

"American astronauts flew to the Moon" To determine the truth or falsity of the hypothesis using the available data, we use abductive reasoning, which involves forming generalizations to bridge the information gap. Here's a step-by-step process:

1. Identify the Patterns of Meaning:

• Hypothesis: "people been to Moon"

• Data: "American astronauts flew to Moon"

2. Form Necessary Generalizations: • Generalization 1: "Astronauts are people."

• Generalization 2:

"They flew to the Moon, so they were there."

3. Apply Abductive Reasoning:

• From Generalization 1, we conclude that "American astronauts" are a subset of "people."

• From Generalization 2, we infer that if astronauts flew to the Moon, they likely landed and were there.

4. Evaluate Reliability:

• The conclusion "They flew, so they were" is plausible but not absolutely certain. There exists a possibility that they could have flown to the Moon but not landed.

5. Conclusion:

Based on the generalizations and the available data, we can reasonably conclude that the statement "people have been to the Moon" is true. However, acknowledging the inherent uncertainty, further data (e.g., confirmation of landing) would enhance the reliability of this conclusion.

Additional Notes on Abductive Reasoning Abductive reasoning does not guarantee unambiguous results; it often requires additional data to increase the certainty of conclusions. In the simplest examples, as shown above, the logical steps involve categorizing types of statements that the AGI processes and progressively refining its reasoning abilities. This method allows for a structured development of AGI, starting with basic algorithmic logic and evolving into more complex inferential capabilities.

13 Applications Beyond AGI

Inspired by Marx and Engels' assertion that "philosophers have only interpreted the world in various ways; the point, however, is to program it," we present a novel approach to tackling the issues of existence, perception, and their connection to cognitive concepts. This methodology, which we term constructive or formalized philosophy, emphasizes rigor and brevity in definitions while adhering to the Occam's razor principle.

13.1 Occam's Razor and Abduction

Occam's razor, a heuristic method for simplifying complex explanations, is central to our approach. By employing abduction—a form of logical inference that seeks the simplest and most likely explanations—we aim to streamline the cognitive process. This simplification is crucial for developing more efficient analytical and predictive models, particularly in the context of Artificial General Intelligence (AGI).

13.2 Set-Theoretical Interpretation and the Hermeneutic Circle

Our method utilizes set-theoretical interpretations to formalize philosophical concepts. A significant example is our take on the hermeneutic circle, traditionally a process of understanding through recursive knowledge formation. We reframe it as a recursive process involving relations on a set of elements and the set itself, driven by data perception via abduction. This reinterpretation highlights the interconnectedness of Occam's razor, abduction, and the hermeneutic circle, all of which describe cognition as a sequential generalization process based on incomplete data.

13.3 Formalizing Philosophical Concepts

The formalization of philosophical concepts enables their programming, quantification, and application to qualitative cognitive assessments. This is particularly vital for the advancement of AGI. By transforming abstract concepts into programmable constructs, we create a foundation for AGI to develop logical statements in natural language.

13.4 Beyond-AGI Applications

While the primary focus is on AGI, this approach has broader applications. It can serve as an alternative to inefficient statistical methods in various analytical and predictive tasks. For instance, in economic or production systems, qualitative assessments can be derived not just from statistical changes in parameters but from evaluating the presence of specific parameter sets with defined values. This methodology aligns well with the practices of AI systems and holds promise for future analytical and predictive AI implementations.

In summary, the principles outlined here offer a structured methodology for AGI development and have potential applications in various analytical fields. By integrating qualitative assessments based on practical experience and formalized philosophical constructs, this approach can significantly enhance the capabilities of AI systems in understanding and predicting complex systems.

14 Conclusion

In conclusion, the advancement towards Artificial General Intelligence hinges on a robust formalization of ”meaning” and ”knowledge” that transcends the limitations of current AI systems. These systems, while proficient in specific tasks, lack the semantic understanding necessary for true human-like cognitive processes. This paper has identified the inadequacies in existing definitions and highlighted the need for a stringent and programmable approach to encapsulate meanings. By developing a structured methodology for encoding and utilizing meanings, we pave the way for AGI systems capable of genuine comprehension and versatile problem-solving. This foundational work is crucial for bridging the gap between human cognition and artificial intelligence, ultimately propelling the field closer to achieving true AGI.

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