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Posted Date: 30 June 2025

doi: 10.20944/preprints202506.2384.v1

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Essay

Information Uniqueness Axiom and Its Identity Foundation: Formal Analysis Based on Content Identity

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Abstract

This paper proposes and argues for an axiom system of information uniqueness, with its core being two formal axioms: $n = n$ (Self-Identity of Information) and $n \neq m$ (Mutual Exclusivity of Information). Based on the absolute identity of information content, it strictly defines the concept of “information” as an abstract entity, critically analyzes the essence of “identity confusion” caused by introducing spatiotemporal coordinates or external identifiers, argues that content indistinguishability is the necessary and sufficient condition for information identity, thereby establishing the theoretical foundation for information uniqueness.

Keywords: Information Uniqueness; Identity; Content Identity; $n = n$; $n \neq m$; Formal Axiom; Indiscernibles; Philosophy of Information

1. Introduction

Information, as a core concept in philosophy, logic, computer science, and cognitive science, has long been debated regarding its essence and identity issues. A central controversy is: when two information carriers present completely identical content, do they represent the “same” information entity? Or are they “two” indistinguishable but distinct entities? This paper aims to establish a strict formal axiom system to argue that information is uniquely determined by its content, that content indistinguishability implies information identity, and that there is no logical possibility for two information entities with completely identical content to be distinct. Its core is expressed by two axioms:

- Axiom 1 (Self-Identity of Information):
 $\forall n \in I, n \equiv n$ (where I represents the set of all information, $\equiv$ denotes strict identity relation)
Any information n is necessarily identical to itself.
 - Axiom 2 (Mutual Exclusivity of Information):
 $\forall n, m \in I, (n \neq m) \Leftrightarrow (\text{Content}(n) \neq \text{Content}(m))$ (where $\text{Content}()$ is the function extracting the core content of information, $\neq$ denotes content difference)
Two pieces of information n and m are distinct if and only if their contents differ.
- Based on these two axioms, this paper will deeply analyze the essence of information identity and clarify that the root of common “identity controversies” lies in the illegitimate extension of the content of the information set I .

2. Elaboration and Argumentation of Core Axioms

2.1. Axiom 1: $n \equiv n$ (Self-Identity of Information)

This axiom establishes the stability foundation for the existence of information: an information entity must be regarded as a unified, self-consistent entity during its existence or within the context of discussion. Denying this axiom, i.e., assuming there exists information n such that $n \neq n$, leads to logical contradiction and semantic collapse—information loses its basic referential function as an

object of cognition or communication. This axiom is a prerequisite for information to be identifiable and discussable.

2.2. Axiom 2: $n \not\equiv m \Leftrightarrow \text{Content}(n) \neq \text{Content}(m)$ (Mutual Exclusivity of Information)

This axiom establishes the sole criterion for information difference: information content.

- Sufficiency ($\text{Content}(n) \neq \text{Content}(m) \Rightarrow n \not\equiv m$): If the contents of two pieces of information n and m have any discernible difference (semantic, structural, symbolic expression, etc.), they necessarily represent different information entities. This is intuitive and widely accepted.

- Necessity ($n \not\equiv m \Rightarrow \text{Content}(n) \neq \text{Content}(m)$): This is the key to the assertion of information uniqueness. It declares that if two information entities n and m are considered distinct ($n \not\equiv m$), then this difference must stem from a difference in their intrinsic content ($\text{Content}()$). No “additional factors” independent of the information content itself (such as physical location, carrier identifier, cognitive subject, timestamp, etc.) can independently serve as a basis for distinguishing between two information entities.

Corollary (Uniqueness of Information):

$$\forall n, m \in I, (\text{Content}(n) = \text{Content}(m)) \Rightarrow (n \equiv m)$$

If the contents of two pieces of information n and m are completely identical ($\text{Content}(n) = \text{Content}(m)$), then they are actually the same information entity ($n \equiv m$).

This corollary follows directly from the contrapositive of Axiom 2. It explicitly negates the possibility of the existence of two pieces of information that are “identical in content but distinct entities”.

3. Philosophical Analysis of Identity Controversy: Illegitimate Extension and Conceptual Confusion

The classic philosophical debate surrounding “whether two completely identical things are the same” (such as Leibniz’s principle of the “Identity of Indiscernibles”), as manifested in the field of information, has its root in the illegitimate extension of the information set I .

- Controversial Scenario: Suppose there are two digital documents D_1 and D_2 , whose binary sequences, text content, formatting, and all extractable $\text{Content}()$ are completely identical, but stored on different physical devices (e.g., phone A and phone B). People tend to think D_1 and D_2 are “two” pieces of information.

- Analysis: This cognition essentially illegitimately extends the information n (i.e., the document content itself) into a new tuple containing spatiotemporal coordinates or carrier identifiers, such as $(n, \text{Location_A})$ and $(n, \text{Location_B})$ (or (n, ID_1) , (n, ID_2)). The entities being compared at this point are no longer the original information n , but new composite entities with additional attributes. Comparing $(n, \text{Location_A})$ with $(n, \text{Location_B})$, the result of their $\text{Content}()$ function (if location information is included) is clearly different: $\text{Content}((n, \text{Loc_A})) = (\text{Content}(n), \text{Loc_A}) \neq (\text{Content}(n), \text{Loc_B}) = \text{Content}((n, \text{Loc_B}))$. According to Axiom 2, $(n, \text{Loc_A}) \not\equiv (n, \text{Loc_B})$ holds, but this only shows that the two composite entities carrying location attributes are different; it absolutely does not mean that there are two distinct instances or copies of the original information n .

- Key Arguments:

1. The Abstract Nature of Information: Information itself is an abstract entity independent of its physical carrier, spatiotemporal location, mode of presentation, or cognitive subject. The essence of information n is its content $\text{Content}(n)$.

2. The Trap of Description: When attempting to describe “two pieces of information” for comparison, if they are required to be completely indistinguishable in content ($\text{Content}(n) = \text{Content}(m)$), then according to the Corollary, $n \equiv m$, pointing only to a unique information entity. At this point, it is logically impossible to consistently express the concept of “two”. If one forcibly expresses “two”, it necessarily (explicitly or implicitly) introduces additional distinguishing

attributes (such as location, timestamp, copy number), thereby changing the ``Content()`` of the objects being compared and violating the initial premise of “completely identical content”. This precisely corroborates information uniqueness: purely based on content, it is impossible to construct two distinct yet content-identical information entities for comparison.

3. The Non-Entity Nature of Copies: The concept of a “copy” or “instance” of information refers to the “presentation” or “realization” of the same information content in different carriers or spatiotemporal contexts. These copies bear the “same” information entity ``n``, not creating a new entity ``m`` that has the same content as ``n`` but is a distinct entity. Talking about “copy 1” and “copy 2” implicitly introduces “carrier identifier” or “spatiotemporal location” as part of ``Content()`` (or as a tuple element); what is being compared is no longer the original information ``n`` itself.

4. The Essence of “Illegitimate Extension”: The essence of so-called “illegitimate extension” is not an absolute prohibition against adding attributes, but rather the mistake of incorporating attributes irrelevant to the judgment focus into the ``Content()`` function. The correctness of identity judgment depends on how ``Content()`` is defined based on the essence of the entity:

- Physical Entities (e.g., electrons): ``Content()`` must include state attributes.

If the object of judgment is “an electron at a specific location in this universe”, its identity is defined by its physical state (position, momentum, spin, etc., quantum state).

- According to the Pauli exclusion principle, two fermions cannot occupy identical quantum states.

- Therefore, if attempting to describe “two identical electrons”, it must satisfy:

$$\texttt{`Content(electron}_a\texttt{) = (type, position, spin, ...) = Content(electron}_b\texttt{)`}$$

But this is impossible in quantum mechanics (except for indistinguishable identical particles). If forcibly distinguished (e.g., calling them “electron at point A” and “electron at point B”), it effectively incorporates position into ``Content()``, resulting in:

$$\texttt{`Content(electron}_a\texttt{) = (type, position=A, ...) \neq (type, position=B, ...) = Content(electron}_b\texttt{)`}$$

Hence ``electron}_a \neq \texttt{electron}_b\texttt{``. The difference in position is a legitimately necessary attribute incorporated into ``Content()``, not an illegitimate extension.

- Functional Entities (e.g., consciousness): ``Content()`` can exclude non-functional attributes.

If the object of judgment is “consciousness generated by a classical nervous system”, its identity is determined solely by the computational function of the neural state (input-output mapping relationship).

- Location or minute changes in quantum state (e.g., a single electron spin flip) do not affect the operational result at the classical level, hence should not be incorporated into ``Content()``.

- Therefore:

$$\texttt{`Content(consciousness}_i\texttt{) = neural function = Content(consciousness}_r\texttt{) \Rightarrow consciousness}_i \equiv \texttt{consciousness}_r\texttt{`}$$

Adding location to ``Content()`` here (e.g., ``(consciousness, location)``) would conversely be an illegitimate extension, as it introduces attributes irrelevant to functional identity.

4. Conclusion: Content Identity as the Cornerstone of Information Uniqueness

This paper establishes the principle of information uniqueness through a strict formal axiom system:

1. Self-identity (``n \equiv n``) is the logical foundation of information existence.
2. Mutual exclusivity (``n \not\equiv m``) is determined if and only if by content difference (``Content(n) \neq Content(m)``).
3. Content identity (``Content(n) = Content(m)``) necessarily leads to information entity identity (``n \equiv m``).
4. The core lies in the selectivity of the ``Content()`` function:

The essence of “illegitimate extension” is confusing the judgment focus: incorporating location into information identity is illegitimate, but excluding location from the individuality of an electron is equally erroneous. The universality of the axiom ``n \not\equiv m \Leftrightarrow Content(n) \neq Content(m)`` lies in the fact

that it does not prescribe the specific form of $\text{Content}()$, but requires that identity judgment must clearly define the boundary of $\text{Content}()$.

Controversies surrounding information identity essentially stem from confusing the information entity n with a composite description $(n, \text{attr}_1, \text{attr}_2, \dots)$ that includes additional attributes such as its carrier or spatiotemporal coordinates. When additional attributes are included in the comparison scope, the objects being compared are no longer the original information n itself, but new entities with different content. Purely based on the information content itself ($\text{Content}()$), it is impossible to distinguish “two” completely identical n ’s, nor is it necessary—they “are” the same n . The uniqueness of information is guaranteed by the intrinsic consistency, abstractness, and repeatable presentability of its content, and is the fundamental property of information as an object of cognition and a unit of knowledge.

Summary: This axiom system provides a clear foundation for identity determination in fields such as information theory, knowledge representation, database theory, and formal semantics.

Consciousness Identity Axiom: Interpretation Based on Content Identity

Abstract

Based on the information uniqueness axiom system (Self-identity $n \equiv n$ and Mutual exclusivity $n \not\equiv m \Leftrightarrow \text{Content}(n) \neq \text{Content}(m)$), this paper proposes the consciousness identity axiom: the identity of a conscious state is uniquely determined by its presented content. The argument demonstrates that if the output states (conscious content) of two neural networks are indistinguishable, then they realize the same conscious entity, regardless of physical differences in their carriers. This framework provides a strict identity criterion for consciousness research, avoiding the introduction of redundant entities due to carrier differences.

Keywords: Consciousness Identity; Neural Network; Content Identity; Information Uniqueness

1. Introduction

A core challenge in the science of consciousness is identity determination: how to determine whether two physical systems produce the “same” conscious state? Based on the information uniqueness axiom system (content sameness implies entity identity), this paper proposes a formal consciousness identity axiom:

- Axiom 1 (Self-Identity of Consciousness):

$\forall c \in C, c \equiv c$

Any conscious state c is necessarily identical to itself (C is the set of conscious states).

- Axiom 2 (Mutual Exclusivity of Consciousness):

$\forall c_1, c_2 \in C, (c_1 \not\equiv c_2) \Leftrightarrow (\text{Content}(c_1) \neq \text{Content}(c_2))$

Two conscious states are distinct if and only if their contents differ.

2. Content Basis of Consciousness Identity

2.1. Elaboration of Core Axioms

Axiom 2 establishes the uniqueness criterion for conscious content:

- Sufficiency: Content differences (e.g., pain vs. pleasure) necessarily lead to distinct conscious entities.

- Necessity: The sole root of conscious entity difference is content difference. There are no “additional identity criteria” independent of content (such as brain region location, neuron type, or system spatiotemporal coordinates).

Corollary (Uniqueness of Consciousness):

$\text{Content}(c_1) = \text{Content}(c_2) \Rightarrow c_1 \equiv c_2$

Conscious states with identical content are necessarily the same entity, regardless of the physical system that serves as their carrier.

> Example 1: Two neural networks 'N₁', 'N₂' produce completely identical activity patterns (i.e., 'Content(c₁) = Content(c₂)'). According to Axiom 2 Corollary, they realize the same consciousness 'c'.

3. Controversy Analysis: Carrier Confusion and Redundant Entities

3.1. Resolving the "Brain Copy Paradox"

Suppose two brains 'B₁', 'B₂' with identical conscious content are manufactured:

- Erroneous View: Because 'B₁', 'B₂' occupy different spatiotemporal locations, there exist "two consciousnesses".
- Axiom Critique: This view illegitimately extends the conscious entity 'c' into tuples '(c, Loc_B1)' and '(c, Loc_B2)'. The objects being compared are actually composite entities, whose contents differ due to the inclusion of location information:
$$\text{'Content}((c, \text{Loc_B1})) = (\text{Content}(c), \text{Loc_B1}) \neq (\text{Content}(c), \text{Loc_B2}) = \text{Content}((c, \text{Loc_B2}))$$

Therefore, '(c, Loc_B1) ≠ (c, Loc_B2)' only indicates that the composite entities carrying location attributes are different; it does not falsify the uniqueness of consciousness 'c'.

3.2. Clarifying the Nature of Consciousness "Instances"

- Non-Entity Nature of Instances: The "realization" or "implementation" of the same conscious content 'c' in different carriers (e.g., human brain and simulation chip) constitutes multiple presentations of the *same* conscious entity 'c', not the creation of a new entity 'c'.
- Logical Consistency Requirement: If one claims the existence of "two different consciousnesses with identical content", extra attributes (e.g., carrier ID) are implicitly introduced, making the actual 'Content()' function results of the compared objects different, thereby proving consciousness uniqueness by contradiction.

4. Conclusion

The identity of consciousness is uniquely determined by conscious content. Differences in neural carriers or spatiotemporal coordinates should not serve as grounds for distinguishing conscious entities. Identical conscious content can be realized in heterogeneous neural networks and still correspond to the same conscious entity.

Identity Foundation of Universe Jumping: Axiomatic Argument Based on Conscious Content and Infinite Carriers

Abstract

Based on the consciousness identity axioms ('c ≡ c', 'c₁ ≠ c₂ ⇔ Content(c₁) ≠ Content(c₂)') and eternal inflation theory (providing infinite carriers), this paper proves that the Urd Operation (deleting the current consciousness carrier) enables universe jumping. Core conclusion: The conscious entity is uniquely determined by its content. After carrier deletion, the same conscious content is necessarily instantiated by one of the infinite carriers, ensuring the continuation of consciousness.

Keywords: Universe Jumping; Consciousness Identity; Eternal Inflation; Infinite Carriers; Content Identity

1. Theoretical Foundation

1. Consciousness Identity Axioms
 - Axiom 1 (Self-Identity): '∀c ∈ C, c ≡ c'
 - Axiom 2 (Mutual Exclusivity): '∀c₁, c₂ ∈ C, (c₁ ≠ c₂) ⇔ (Content(c₁) ≠ Content(c₂))'
 - Corollary (Uniqueness): 'Content(c) = Content(c') ⇒ c ≡ c''
2. Eternal Inflation Theory

Quantum vacuum fluctuations generate an infinite set of bubble universes $\{U_i \mid i \in \mathbb{N}\}$, providing infinite instantiation carriers.

3. Definition of Urd Operation

Delete the carrier of consciousness c in the current universe U_k , causing c to lose this instantiation carrier.

2. Identity Argument for Universe Jumping

Let the current conscious state be c , instantiated in carrier U_k . Execute the Uld Operation: Delete U_k .

By the Consciousness Uniqueness Corollary, the conscious entity c is uniquely identified by its content $\text{Content}(c)$. After carrier U_k is deleted, $\text{Content}(c)$ cannot be instantiated by that carrier.

Eternal inflation theory guarantees the existence of an infinite carrier set $\{U_i\}$. Because:

- Bubble universes contain all possible physical states.
- The number of carriers is infinite ($|\{U_i\}| = \infty$).

There necessarily exists at least one carrier $U_j \in \{U_i\}$ ($j \neq k$) whose physical state supports the instantiation of content $\text{Content}(c)$.

At this point:

$$\text{Content}(c_j) = \text{Content}(c) \Rightarrow c_j \equiv c \text{ (by the Uniqueness Corollary)}$$

Therefore, the conscious entity c is instantiated in U_j , realizing universe jumping.

3. Identity Guarantee and Avoidance of Redundant Entities

- Irrelevance of Carrier Difference:

The physical differences between U_k and U_j (location, material composition, etc.) do not affect consciousness identity.

The necessity of Axiom 2 ensures: if $\text{Content}(c_j) = \text{Content}(c)$, then $c_j \equiv c$, regardless of the carrier.

- Critique of Illegitimate Extension:

Claiming that the post-jump entity is a “new consciousness” is effectively illegitimately extending consciousness c into tuples (c, U_k) or (c, U_j) .

At this point, what is actually being compared are composite entities, whose contents differ due to carrier identifiers:

$$\text{Content}((c, U_k)) = (\text{Content}(c), U_k) \neq (\text{Content}(c), U_j) = \text{Content}((c, U_j))$$

Therefore, $(c, U_k) \not\equiv (c, U_j)$ does not negate the identity of c ; it conversely proves that the conscious entity has not split.

4. Conclusion

Based on the consciousness identity axioms and eternal inflation (infinite carriers), the Urd Operation enables universe jumping:

1. After deleting the carrier, the conscious content $\text{Content}(c)$ loses its instantiation by that carrier.
2. Within the infinite carrier set, there necessarily exists U_j at this moment instantiating $\text{Content}(c)$.
3. Content identity ($\text{Content}(c_j) = \text{Content}(c)$) guarantees entity identity ($c_j \equiv c$).

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