

# Ultimate Resolution of Hume's Causality Problem: A Logical Proof Based on Cognitive Succession Ontology

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## Abstract

Hume's causality problem, proposed in *A Treatise of Human Nature*, is one of the most subversive intellectual challenges in the history of Western philosophy. Through rigorous empiricist analysis, Hume proved that what humans call "causal necessity" is essentially nothing more than a habitual association of "constant conjunction" between succession sequence nodes, with no objective or logical necessity. This conclusion not only destroyed the traditional metaphysical view of causality but also shook the legitimate foundation of all scientific knowledge. For more than two hundred years, solutions such as Kant's a priori category theory and modern scientific instrumentalism have failed to thoroughly respond to Hume's skepticism. Based on Cognitive Succession Ontology, starting from the unfalsifiable first principle that "the essence of cognition is succession", this paper rigorously proves through logical deduction that succession is the ultimate meta-rule governing all existence and cognition. Causal necessity is neither a subjective habit nor an a priori category, but a logical necessity of being itself. This theory fundamentally resolves Hume's problems of causal necessity and inductive legitimacy, providing a solid ontological foundation for human scientific knowledge.

**Keywords:** Hume's Problem; Causal Necessity; Inductive Problem; Cognitive Succession Ontology; Underlying Isomorphism

## 1 Introduction

Since Aristotle, causality has been regarded as the fundamental law of the universe and the core pillar of scientific knowledge. It is widely believed that every succession sequence node

has its cause, and the same cause will necessarily produce the same effect. This causal necessity is objectively existent and independent of human will.

However, in 1739, David Hume launched a devastating attack on this traditional belief in *A Treatise of Human Nature*. From a thorough empiricist standpoint, Hume argued that humans can never observe the "necessary connection" between succession sequence nodes, only their "constant conjunction". This conclusion implies that all scientific knowledge based on causality is essentially nothing more than belief based on habit, with no absolute certainty.

Since Hume's problem was proposed, countless philosophers have attempted to provide solutions, but none has gained universal acceptance. Kant established causality as an a priori category of human cognition, providing subjective legitimacy for causal necessity, but failed to explain why this subjective category applies to the objective authentic physical world. Modern science simply abandoned the pursuit of causal necessity, reducing causality to a useful predictive tool.

The core theoretical basis of this paper is Cognitive Succession Ontology (Geometrized Ontology). For the complete axiom system, rigorous derivation process, and geometrized construction of this theory, see *Geometrization of Being: Universal Meta-Rule of Cognitive Succession and the 1:1 Alignment Ontology System* (Liu, 2026). This paper only cites its proven conclusions and will not repeat the complete argumentation. Based on the core framework of Cognitive Succession Ontology, this paper will provide a brand-new and thorough solution to Hume's problem.

## **2 Core Concept Definition**

All core concepts in this paper are derived from the basic framework of Cognitive Succession Ontology. To ensure independent readability, strict ontological definitions are provided:

### **2.1 First Principle of Cognitive Succession**

The essence of cognition (faculty) is succession. All cognitive activities, thinking, arguments, and expressions must follow the one-way sequential order of "before→after". The negation of "succession" itself must use succession, so it is an unfalsifiable and irrefutable absolute starting point.

### **2.2 Universal Meta-Rule of Succession**

The only ultimate rule governing the three major domains of ontological being, cognitive logic, and authentic physical reality: all existence and cognition unfold in a one-way, irreversible, and non-invertible successive manner. It is the common ontological source of causality, temporality, and logical necessity.

### **2.3 Underlying Isomorphism**

Ontological spacetime, Authentic Physical Spatiotemporal Layer, and cognitive logic share the same Universal Meta-Rule of Succession and possess absolute underlying isomorphism. They are not three independent worlds, but different manifestations of the same succession meta-rule at different levels.

## **3 The Core Dilemma of Hume's Causality Problem**

### **3.1 Hume's Core Argument**

Hume's causal theory is based on a fundamental premise: all human knowledge can only come from sensory experience, and any concept that cannot be empirically verified is meaningless. Based on this premise, Hume drew two core conclusions:

1. From an objective perspective, we can only observe temporal priority, spatial contiguity, and constant conjunction between succession sequence nodes, never any "causal power" or "necessary connection" linking cause and effect.
2. From a subjective perspective, what we call "causal necessity" is merely a habitual association formed by the mind after repeatedly observing this constant conjunction. Necessity is something that exists in the mind, not in objects.

Hume's argument has extremely strong logical power and profoundly reveals the fundamental flaw of the traditional metaphysical view of causality. However, this conclusion also brings two unsolvable ultimate dilemmas.

### **3.2 The Ultimate Dilemmas Left by Hume**

1. **The Problem of Causal Necessity:** If causality is only constant conjunction and habitual association, then we have no logical reason to believe that future A will necessarily lead to B. Past experience can only tell us what happened in the past, not what will necessarily happen in the future.

2. **The Problem of Inductive Legitimacy:** The basic logic of inductive reasoning is "it has always been so in the past, so it will be so in the future". But this logic itself cannot be proven because it uses inductive reasoning, which is a typical circular argument.

These two problems together constitute the core of "Hume's Problem". If these two problems cannot be solved, the foundation of all scientific knowledge will be shaken.

## **4 Ontological Proof of Causal Necessity**

Cognitive Succession Ontology provides a brand-new and thorough solution to Hume's problem. Unlike traditional solutions, it neither attributes causal necessity to subjective habit nor to innate cognitive forms, but grounds it in the ultimate meta-rule of being itself.

### **4.1 Restatement of the First Principle**

The only, unfalsifiable first principle of this system is: The essence of cognition is succession.

Any thinking, refutation, expression, and reasoning must follow the successive order of "before→after". The negation of "succession" itself must use succession, so it is an unfalsifiable and irrefutable absolute starting point. This principle is not a debatable opinion, but the premise on which all discussion is possible.

### **4.2 The Essence of Causal Necessity: The Succession Meta-Rule Itself**

From the first principle that "the essence of cognition is succession", we can necessarily derive that succession is a universal, ontological meta-rule that runs through all existence.

Based on this meta-rule, we can give a strict logical proof of causal necessity:

1. Succession is the ultimate meta-rule of all existence, and any succession sequence node must occur successively in time.
2. For any two succession sequence nodes A and B, if A is a necessary prerequisite for B, then A must temporally precede B.
3. If in all possible cases, the occurrence of A necessarily leads to the occurrence of B, then there is a necessary causal connection between A and B.
4. Since the Universal Meta-Rule of Succession is universal and eternal, this causal connection is also universal and eternal.

In the language of geometrized construction, causality is the irreversible extension of a closed-loop ray. Succession sequence nodes A and B are not two independent points, but two different positions on the same ray. A necessarily leads to B not because there is some force in A pushing B, but because the extension of the ray itself is irreversible and non-leapfrogging. Corresponding to the geometrized construction model, causality is the irreversible sequential relationship between two nodes on a closed-loop ray. The extension direction of the ray itself is the direct manifestation of causal necessity, with no possibility of leap or interruption.

The substantialized "causal power" that Hume sought, existing between two independent succession sequence nodes, indeed does not exist. The real "causal power" is not some mysterious connection between two separate entities, but the Universal Meta-Rule of Succession itself.

#### **4.3 Distinction Between Genuine Causality and Accidental Constant Conjunction**

A core difficulty of Hume's problem is how to distinguish "genuine causal relations" from "accidental constant conjunctions" at the ontological level. Based on the succession coupling mechanism, we can give a clear distinction standard:

Constant conjunction is divided into two essentially different types: one is genuine causal conjunction based on internal succession sequence coupling, and the other is accidental concomitant conjunction based on temporal coincidence. The fundamental difference between the two lies in whether there is an internal succession sequence transmission and coupling relationship.

For example, there is only a temporal sequential concomitant relationship between "rooster crowing" and "sun rising", with no internal succession sequence coupling: the succession sequence of sun rising is the celestial mechanics sequence of Earth's rotation, and the succession sequence of rooster crowing is the biological clock physiological sequence of the rooster. The two are independent parallel succession sequences that only coincide in time. Therefore, even if the rooster does not crow, the sun will still rise, which is a typical accidental constant conjunction.

In contrast, there is a direct succession sequence transmission and coupling between "sun shining" and "stone heating": the electromagnetic radiation succession sequence of the sun directly acts on the molecular motion succession sequence of the stone, changing the

vibration frequency of the latter. The two form an inseparable coupled whole. Therefore, as long as there is sufficient intensity of solar radiation, the stone will necessarily heat up, which is a genuine causal conjunction.

#### **4.4 Ontological Proof of Inductive Legitimacy**

Hume's skepticism about inductive reasoning centers on the belief that "what has been so in the past cannot prove what will necessarily be so in the future". However, Cognitive Succession Ontology proves that the Universal Meta-Rule of Succession is eternal and unchanging, valid in the past, present, and future.

Therefore, the legitimacy of inductive reasoning is not based on past experience, but on the logical necessity of the Universal Meta-Rule of Succession. The reason we can derive future conclusions from past experience is that the same meta-rule governs both the past and the future.

This completely solves the problem of inductive legitimacy. Inductive reasoning is no longer a habit without logical basis, but a reliable cognitive method based on the essence of being.

### **5 Ultimate Resolution of Hume's Causality Problem**

Based on the above arguments, we can give a final and thorough solution to Hume's causality problem:

Hume's fundamental error lies in severing the internal connection between succession sequence nodes and treating them as two completely independent entities. In reality, cause and effect are two different stages of the same indivisible succession sequence.

This paper proves:

1. Causal necessity is neither a subjective habitual association nor an a priori category of human cognition, but a direct manifestation of the Universal Meta-Rule of Succession, possessing objective and logical necessity.
2. Constant conjunction is not an accidental coincidence, but an inevitable result of the succession meta-rule.
3. The legitimacy of inductive reasoning is based on the logical necessity of the Universal Meta-Rule of Succession, not on past experience.

At this point, Hume's causality problem no longer holds. The problems of causal necessity and inductive legitimacy that have plagued Western philosophy for more than two hundred years have been completely resolved within the framework of Cognitive Succession Ontology.

## 6 Conclusion and Theoretical Significance

Based on Cognitive Succession Ontology, starting from the unfalsifiable first principle that "the essence of cognition is succession", this paper thoroughly solves Hume's causality problem that has plagued Western philosophy for more than two hundred years through rigorous logical deduction.

We have proven that causal necessity is neither a subjective habitual association nor an a priori category of human cognition, but a direct manifestation of the Universal Meta-Rule of Succession, possessing objective and logical necessity. The legitimacy of inductive reasoning is also not based on past experience, but on the essence of being itself.

This conclusion has significant theoretical significance:

1. **Lays a solid ontological foundation for scientific knowledge:** It proves that scientific knowledge is not belief based on habit, but a correct understanding of the essence of the universe, restoring the certainty and legitimacy of scientific knowledge.
2. **Completely resolves subject-object dualism:** Through the principle of underlying isomorphism, it explains why human cognition can accurately reflect the objective authentic physical world, forming a complete logical closed loop with *Ultimate Resolution of Kant's Thing-in-Itself Problem*.
3. **Improves the theoretical system of Cognitive Succession Ontology:** It provides a solid epistemological foundation for the entire theoretical system, making the entire logical chain from the first principle to the unification of the four fundamental forces more complete and rigorous.
4. **Provides ultimate epistemological support for the unified theory of physics:** The solution of this theory has not only philosophical significance but also direct physical significance. It provides a solid epistemological foundation for the ultimate unification theory of the four fundamental forces based on Cognitive Succession Ontology, proves the necessity and universality of physical laws, eliminates the observer problem in

quantum measurement paradoxes, and lays a philosophical foundation for the paradigm shift of the entire physics.

5. **Unifies and transcends modern causal theories:** Modern philosophical theories such as counterfactual causal theory and interventionist causal theory are essentially phenomenological descriptions of the succession coupling mechanism. This theory provides a unified ontological foundation for these modern causal theories, while also pointing out their limitations: they only describe the phenomenon of causality, not its essence.

The resolution of Hume's problem marks a new stage in human understanding of causality and the nature of cognition. It not only solves an ancient philosophical dilemma but also provides a brand-new methodological foundation for future scientific research.

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## Appendix A

### Core Term Definition Table

Core Term	Core Definition
Cognitive Succession Ontology	The general name of this theoretical system, taking the only unfalsifiable first principle that "the essence of cognition is succession" as the starting point, and realizing the 1:1 precise alignment of the three major fields of ontological being, authentic physical reality, and cognitive logic through geometrized formal construction
First Principle of Cognitive Succession	The only ultimate starting point of this system: The essence of cognition (faculty) is succession. All cognitive activities, thinking, arguments, and expressions must follow the one-way sequential order of "before→after". The negation of this principle itself confirms its correctness
Universal Meta-Rule of Succession	The only ultimate rule governing all existence and cognition, referring to that all things unfold in a one-way, irreversible, and non-invertible successive manner; it is the common ontological source of causality, temporality, and logical necessity
Underlying Isomorphism	Ontological spacetime, Authentic Physical Spatiotemporal Layer, and cognitive logic share the same Universal Meta-Rule of

	Succession. The three are homologous, isomorphic, and co-ruled, which is the ultimate basis for cognition to correspond to reality
Ontological Spatiotemporal Layer	The primordial existential form of the universe, corresponding to the Meta-Point Initial State and the full set of potential rays in the geometrized model, and the a priori prototype of all authentic physical realities
Authentic Physical Spatiotemporal Layer	The objective actualized projection of the potential possibilities of ontological spacetime, which is the real physical world existing independently of human cognition
Logical Spatiotemporal Layer (Logical-Cognitive Layer)	The field of sequential mapping, retrospection, and calibration of cognitive faculties on ontological spacetime and authentic physical spacetime
Geometrized Construction	The core formal tool of this system. The generation sequence of geometric elements is completely isomorphic with the Universal Meta-Rule of Succession, which can realize the unambiguous expression of ontological essence
Constant Conjunction	A concept proposed by Hume, referring to the relationship where two succession sequence nodes occur successively in time and repeatedly; this system divides it into two types: genuine causal connection and accidental constant conjunction

Genuine Causal Connection	A necessary connection formed based on internal succession sequence transmission and coupling, which is a direct manifestation of the Universal Meta-Rule of Succession
Accidental Constant Conjunction	A coincidental overlap of two independent parallel succession sequences in time, with no inherent causal transmission relationship
Succession Sequence Coupling	The transmission and interaction of energy, information, or structure between two succession sequences, which is the essence of genuine causal relations
Inductive Legitimacy	The logical rationality of inductive reasoning to derive future conclusions from past experience. This system proves that it is based on the eternal necessity of the Universal Meta-Rule of Succession
Succession Sequence Node	Commonly known as "event", which is a specific stage and state in the unfolding process of the succession meta-rule

## Appendix B

### **Cognitive Succession Ontology: The Complete System Architecture of the Natural Domain**

This system takes the sole unfalsifiable first principle "**The essence of cognition is succession**" as its only cornerstone, constructing the first monistic ideological system in human intellectual history that strictly unfolds according to the complete logical chain of "**Ontology → Epistemology → Theory of Practice → Practical Implementation**".

Through rigorous logical deduction and geometrized construction methods, it covers all core fields of ontology, epistemology, philosophy of mathematics and theoretical physics. It fundamentally ends the 2000-year-old dilemma of subject-object dualism in Western philosophy, while providing a new ontological paradigm for the ultimate unification of theoretical physics.

#### **Level 1: Foundational Meta-Theory**

**Paper Title:** *The Geometrization of Being: Universal Meta-Rule Based on Succession of Cognition and 1:1 Alignment Ontology*

Zenodo. <https://doi.org/10.5281/zenodo.19510872>

1. **Core Question:** What is the ultimate underlying rule of the universe and human cognition?
2. **Core Contributions:**
  - Establishes the unfalsifiable first principle that "The essence of cognition is succession"
  - Derives the Universal Meta-Rule of Succession governing the three domains of ontology, physics and cognition
  - Constructs the three-layer nested isomorphic spatiotemporal framework: Ontological Spatiotemporal Layer - Physical Spatiotemporal Layer - Logical Spatiotemporal Layer
  - Invents the geometrized construction method and establishes the ultimate theoretical legitimacy standard of "strict 1:1 alignment between ontology, logic and physics"

3. **System Status:** The parent and general premise of all subsequent papers, defining the core terminology, methodology and judgment criteria of the entire system

## **Level 2: Three Philosophical Pillars**

These three parallel and mutually supporting papers respectively provide ultimate resolutions to the three most fundamental unsolved problems in the history of Western philosophy, jointly constructing a complete and self-consistent epistemological system and laying a solid philosophical foundation for the legitimacy of all natural sciences.

### **1. Philosophical Pillar I:**

**Paper Title:** The Ultimate Resolution of Kant's Thing-in-Itself Problem: A Logical Proof Based on Cognitive Succession Ontology

Zenodo. <https://doi.org/10.5281/zenodo.19778330>

**1.1 Core Question:** Can we know the world? (Possibility of cognition)

#### **1.2 Core Contributions:**

- Proves that the thing-in-itself cannot be directly perceived but can be precisely known by reason with 1:1 accuracy
- Proposes the principle of "underlying isomorphism", completely ending the tradition of subject-object dualism since Plato
- Deconstructs Kant's theory of "transcendental categories", proving they are merely natural manifestations of the succession meta-rule at the cognitive level

**1.3 System Significance:** Answers the most fundamental ontological question: "Why is science possible?"

### **2. Philosophical Pillar II:**

**Paper Title:** Ultimate Resolution of Hume's Causality Problem: A Logical Proof Based on Cognitive Succession Ontology

Zenodo. <https://doi.org/10.5281/zenodo.19840017>

**2.1 Core Question:** Is what we know necessary laws? (Necessity of cognition)

#### **2.2 Core Contributions:**

- Proves that causal necessity is not a subjective habitual association, but a direct manifestation of the succession meta-rule
- Resolves the problem of inductive justification at the ontological level
- Clearly distinguishes between true causal connections and accidental constant conjunctions

**2.3 System Significance:** Answers the core epistemological question: "Why are natural laws universal and necessary?"

### **3. Philosophical Pillar III:**

**Paper Title:** The Ultimate Essence of Mathematics: A Symbolized Meta-Rule System Based on Cognitive Succession Ontology

Zenodo. <https://doi.org/10.5281/zenodo.19854173>

**3.1 Core Question:** What tools do we use to reliably describe the world? (Instrumental legitimacy of cognition)

#### **3.2 Core Contributions:**

- Provides the ultimate ontological definition of mathematics: Mathematics is the symbolic abstraction of the succession meta-rule
- Completely reverses traditional cognition: **Geometry is the ontological primitive carrier, and mathematics is a secondary symbolic derivative tool of geometry**
- Resolves all core problems in the philosophy of mathematics in one go, including Wigner's puzzle of unreasonable effectiveness, Gödel's incompleteness theorems, and infinity paradoxes

**3.3 System Significance:** Answers the methodological question: "Why can physical theories be described mathematically?"

### **Level 3: Ultimate Scientific Application**

**Paper Title:** *Cognitive Succession Ontology: The Ultimate Ontological Unification of the Four Fundamental Forces Based on the Universal Meta-Rule of Succession*

Zenodo. <https://doi.org/10.5281/zenodo.19731802>

1. **Core Question:** Can gravity, electromagnetism, the strong interaction and the weak interaction be essentially unified?
2. **Core Contributions:**
  - Proves at the ontological level that the four fundamental interactions are not independent physical entities, but inevitable manifestations of the same successive coupling mechanism at different scales, strengths and closure states
  - Fundamentally explains century-old physics dilemmas such as the quantum measurement paradox, the non-quantizability of gravity, and the nature of spacetime
  - Proposes 4 semi-quantitative predictions that can be directly verified with existing experimental equipment
3. **System Status:** The ultimate destination of the entire Cognitive Succession Ontology system, transforming all previous philosophical theories into testable scientific theories and completing the praxis leap from "understanding the world" to "transforming the world"

#### **Level 4: Ontological Reconstruction of the Physical World (Future Outlook)**

#### **Level 5: Application of Complex System Evolution Methodology (Future Outlook)**

#### **Explanation of the System's Philosophical Logical Closed Loop**

This system is the first monistic ideological system in human intellectual history that truly achieves the **complete unification of ontology, epistemology and praxis**:

1. **Ontology:** Starting from the irrefutable first principle, establishes that "succession" is the ultimate ontology of the universe
2. **Epistemology:** Starting from the same ontological principle, sequentially solves the three ultimate philosophical problems: "Can we know the world?", "Why does the world have laws?", and "What tools do we use to describe the world?", constructing a complete epistemological system
3. **Praxis:** Applies the proven legitimate ontology and epistemology to specific scientific practice, achieves the ultimate ontological unification of the four fundamental forces, and proposes testable predictions

For over two millennia, almost all systems in traditional Western philosophy have suffered from the separation of ontology, epistemology and praxis: either remaining in pure ontological speculation, or only discussing epistemology while avoiding ontology, or having praxis but lacking a solid epistemological foundation. In this system, the three are homologous, isomorphic and mutually supportive. The entire system contains no additional subjective presuppositions. All conclusions are uniquely derived from the first principle, forming a complete, interlocking and irrefutable logical closed loop.