The Ontological Neutrality Theorem: Why Neutral Ontological Substrates Must Be Pre-Causal and Pre-Normative

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Abstract

Modern data systems must support accountability across persistent legal, political, and analytic disagreement. This requirement imposes strict constraints on the design of any ontology intended to function as a shared substrate. We establish an impossibility result for ontological neutrality: neutrality, understood as interpretive non-commitment and stability under incompatible extensions, is incompatible with the inclusion of causal or normative commitments at the foundational layer. Any ontology that asserts causal or deontic conclusions as ontological facts cannot serve as a neutral substrate across divergent frameworks without revision or contradiction. It follows that neutral ontological substrates must be pre-causal and pre-normative, representing entities, together with identity and persistence conditions, while externalizing interpretation, evaluation, and explanation. This paper does not propose a specific ontology or protocol; rather, it establishes the necessary design constraints for any system intended to maintain a shared, stable representation of reality across conflicting interpretive frameworks.

Statement of Result (Preview). *Let $\mathcal{O}$ be an ontology intended to function as a neutral substrate across diverse interpretive frameworks. Then $\mathcal{O}$ satisfies the requirements of neutrality if and only if its foundational Level of Abstraction excludes causal and normative primitives.*

Informally: Neutrality is not achieved by finding uncontested causes, but by externalizing the category of causation entirely. To be a substrate for disagreement, an ontology must be pre-causal and pre-normative.

The formal statement and proof appear in Section 4.

Keywords: Formal ontology; ontological neutrality; accountability; neutrality constraints; extension stability; deontic and causal commitment

1 Introduction: Accountability, Disagreement, and Neutral Substrates

Data systems operate in environments characterized by persistent disagreement Rawls [1993], Sunstein [1996]. Legal interpretations diverge across jurisdictions and over time Dworkin [1986], Hart [1961], Berman [2007]; political actors contest responsibility and intent Bovens [2007], Hood [2011]; analytic frameworks disagree about causation, attribution, and relevance Pearl [2009], Woodward [2003]. These disagreements are not anomalies to be resolved prior to data representation. They are structural features of modern industry and society that any accountability-oriented system must accommodate.

Accountability, in this context, requires more than the collection of records or the publication of datasets Fox [2007], Bovens et al. [2014]. It requires the ability to refer stably to entities, actions, and institutional artifacts while allowing competing explanations, evaluations, and judgments to coexist Gruber [1993], Smith and Ceusters [2010]. A system that collapses disagreement by embedding a single interpretation into its foundational representations undermines accountability rather than supporting it, as it

forecloses contestation and revision Bowker and Star [1999], Winner [1980].

This paper is concerned with the implications of this requirement for ontology design. Specifically, it addresses the conditions under which an ontology can function as a neutral substrate for accountability: a shared representational base that remains usable across incompatible legal, political, and analytic frameworks. Under this conception of neutrality, such a substrate must support the coexistence of divergent interpretations without requiring revision of the substrate itself. This requires a careful selection of the Level of Abstraction (LoA) Floridi [2008] at which the substrate operates. Following Floridi, we argue that an LoA is defined by the set of observables it makes available; for a substrate to remain neutral, it must operate at an LoA that excludes explanatory or evaluative observables.

The central claim of this paper is that this form of neutrality imposes strict design constraints. In particular, ontologies that assert causal or normative conclusions at the foundational layer cannot satisfy the requirements of interpretive non-commitment and extension stability that neutrality demands Hacking [1999], Cartwright [1979], Star and Ruhleder [1996], Guarino et al. [2009]. When causal relations or deontic judgments are embedded as ontological facts, the substrate necessarily privileges one framework over others, rendering it incompatible with at least some admissible interpretations.

Rather than proposing an ontology or protocol, this paper establishes these constraints at a meta-level. It formalizes neutrality in terms of interpretive non-commitment and stability under incompatible extensions, and shows that these requirements are incompatible with causal or normative commitments at the substrate layer. The result is an impossibility claim: no ontology that embeds contested causal or deontic conclusions can serve as a neutral substrate for accountability across disagreement.

The remainder of the paper proceeds as follows. Section 2 reviews related work in ontology design, legal informatics, and causal modeling, situating the present contribution. Section 3 defines the notion of a neutral substrate and specifies the two neutrality requirements relevant to accountability

systems. Section 4 presents an impossibility argument showing why causal and normative commitments violate these requirements. Section 5 discusses the implications of this result for ontology design, clarifying what must be excluded from foundational layers and what may be externalized to interpretive frameworks. Section 6 summarizes the resulting constraints and discusses their relevance for ontology design in accountability contexts.

2 Related Work

The constraints developed in this paper intersect with several lines of prior work: upper ontologies in formal ontology research, domain ontologies for legal and institutional reasoning, and causal modeling frameworks. This section situates the present contribution relative to each, clarifying both debts and departures.

2.1 Political Philosophy: Reasonable Pluralism

The premise that disagreement is structural rather than resolvable draws on Rawls' concept of reasonable pluralism Rawls [1993]. Rawls argues that under conditions of free inquiry, reasonable persons will arrive at incompatible comprehensive doctrines.

This paper transposes that insight to ontology design: if interpretive disagreement is a permanent feature of accountability contexts, then neutral substrates must accommodate it structurally rather than resolving it by fiat. The impossibility result formalizes this accommodation as a constraint on admissible observables. Rawls' argument is not imported as a normative foundation, but as an analogy for the persistence of disagreement that motivates the need for structural accommodation.

2.2 Upper Ontologies: BFO and DOLCE

The Basic Formal Ontology (BFO) International Organization for Standardization and International Electrotechnical Commission [2021], Arp et al. [2015] and the Descriptive Ontology for Linguistic and Cognitive Engineering (DOLCE) Borgo et al. [2022a], Masolo et al. [2003] represent two influential approaches to foundational ontology design. Both aim to provide domain-independent upper-level categories that can be extended for specific applications. A recent special issue Borgo et al. [2022b] provides systematic comparison of seven foundational ontologies (BFO, DOLCE, GFO, GUM, TUpper, UFO, YAMATO) through common modeling cases, illustrating both their shared commitments and divergent design choices.

BFO distinguishes continuants from occurrents and provides a realist framework grounded in scientific practice. DOLCE takes a more cognitive and linguistic orientation, emphasizing the role of conceptualization in ontological commitment. Both have been widely adopted in biomedical, engineering, and information systems contexts.

The present work addresses a different question: it analyzes the logical consequences of embedding interpretive commitments at the substrate level, rather than the adequacy or intent of any particular foundational ontology. BFO and DOLCE provide categorical structure for what exists; they do not explicitly address the conditions under which an ontology can remain neutral across interpretive disagreement. These frameworks are often extended in practice to include causal and normative relations as first-class ontological commitments. The impossibility result established here implies that such extensions, if embedded at the substrate layer, compromise neutrality in the sense required for accountability systems.

In Floridi's terms, while BFO and DOLCE define the Level of Organization for physical and social reality, they do not mandate a specific Level of Abstraction that excludes interpretive predicates. Our contribution is to show that for the specific purpose of neutrality, such a mandate is a logical

necessity.

Guarino's analysis of ontological commitment Guarino et al. [2009] clarifies what it means for an ontology to assert something; the present contribution identifies which such assertions are incompatible with neutrality.

This paper's constraints are therefore compatible with BFO or DOLCE as upper-level scaffolding, provided that causal and normative commitments are externalized to interpretive layers rather than embedded in the foundational substrate. Recent work on formal alignment between BFO and DOLCE Masolo et al. [2025] demonstrates that even foundational ontologies with divergent commitments can be mapped systematically, reinforcing the feasibility of neutral substrates that support multiple interpretive frameworks.

Whether specific versions or extensions of BFO, DOLCE, or other upper ontologies satisfy these constraints in practice is an empirical question beyond the scope of this paper. Such compatibility assessments require detailed analysis of particular ontology versions and their commitments, work that would benefit from collaboration with the communities that maintain and extend these frameworks.

2.3 Legal Ontologies: LKIF and Related Approaches

Legal ontologies, such as the Legal Knowledge Interchange Format (LKIF) Hoekstra et al. [2007], and related frameworks Sartor et al. [2011], Breuker and Hoekstra [2009] aim to represent legal concepts, norms, and reasoning patterns in machine-processable form. These ontologies typically include deontic categories, such as obligation, permission, and prohibition, as core primitives, along with relations for legal causation, responsibility, and compliance.

Such frameworks are valuable for legal reasoning and case analysis within a fixed normative framework. However, they are not designed to function as neutral substrates across incompatible legal or political interpretations. By embedding deontic conclusions as ontological facts at the foundational

layer, they necessarily privilege one normative stance over others. When legal interpretations diverge, as they routinely do across jurisdictions, over time, or under political contestation, the substrate itself must be revised to accommodate disagreement.

The impossibility result in this paper applies directly to such designs. LKIF and similar ontologies are appropriate for interpretive layers built atop a neutral substrate, but they cannot themselves serve as the substrate if neutrality across disagreement is required.

2.4 Causal Modeling: Pearl and Structural Approaches

The structural causal modeling framework developed by Pearl Pearl [2009] and extended by others Woodward [2003], Spirtes et al. [2000] provides rigorous tools for representing and reasoning about causation. The do-calculus and related interventionist semantics have become standard in causal inference across multiple disciplines.

These frameworks make explicit causal commitments: they assert that certain variables cause others under specified structural assumptions. Such commitments are essential for causal reasoning but are inherently model-dependent. Different causal models, each internally consistent, may disagree about which relations are causal, which variables are confounders, and which interventions produce which effects.

The present work does not dispute the value of causal modeling for explanation and decision-making. Rather, it observes that causal conclusions are framework-relative in the same structural sense as normative conclusions. Embedding causal relations as substrate-layer primitives privileges one model over others, violating interpretive non-commitment. Causal reasoning must therefore be externalized to interpretive layers where model assumptions are explicit and disagreement can be represented without substrate revision.

2.5 Philosophy of Information: Levels of Abstraction

The methodological framework of this paper is informed by Floridi's Philosophy of Information Floridi [2008, 2011]. Floridi introduces the Method of Levels of Abstraction (LoA) as a way to specify the epistemic range of a system through a set of observables. Crucially, Floridi distinguishes between the LoA (the lens through which a system is viewed) and the Level of Organization (LoO), which refers to the internal structural hierarchy of the system itself.

While Floridi uses these concepts to analyze the nature of data and knowledge, this paper applies them specifically to the problem of ontological neutrality. We argue that neutrality is a function of operating at a foundational LoO with a deliberately restricted LoA. This paper extends Floridi's work by proving that certain classes of observables, causal and normative, necessarily introduce interpretive entropy that renders an LoA unstable with respect to extensions.

2.6 Information Infrastructure: Boundary Objects

Star and Griesemer's concept of boundary objects Star [1989], Star and Ruhleder [1996] and subsequent work on classification systems Bowker and Star [1999] address how representations can be shared across communities with divergent interpretive frameworks. Boundary objects are plastic enough to adapt to local needs yet robust enough to maintain identity across sites.

The neutral substrate concept developed here can be understood as a formalization of this insight: the substrate provides the shared identity structure, while interpretive frameworks supply local meaning. The impossibility result specifies what cannot be shared at the boundary level without losing plasticity.

2.7 Positioning the Present Contribution

The contribution of this paper is a meta-theoretical constraint. Unlike BFO and DOLCE, it does not propose a specific taxonomy of entities; rather, it defines the informational boundary that any such taxonomy must respect to remain neutral.

Recent work has questioned the stability of top-level ontological commitments in emerging technical domains. Köhler and Neuhaus argue that large language models exhibit a *mercurial* ontological status: their classification shifts depending on task framing, deployment context, and explanatory purpose Köhler and Neuhaus [2025]. This observation supports the present result by illustrating that even top-level ontological categories cannot be guaranteed to remain stable when interpretive predicates are embedded, reinforcing the need, where neutrality across uses is required, for a neutrality-preserving substrate beneath such shifting conceptualizations.

Recent work also emphasizes that ontology development itself requires negotiating consensus among stakeholders with divergent commitments Neuhaus and Hastings [2022]. This observation reinforces the present argument by contrast: while temporary disagreement during ontology construction may be instrumental in converging on a sound design, ontologies intended to operate after construction in contexts of valid and persistent interpretive disagreement among admissible frameworks cannot rely on consensus as a foundational design assumption. Instead, such ontologies must, in these contexts, be structured to accommodate disagreement structurally without requiring its resolution. The impossibility result specifies the formal constraint such accommodation must satisfy.

Recent ontology engineering work has emphasized tool-supported maintenance and rapid evolution in fast-moving domains. For example, the Artificial Intelligence Ontology (AIO) employs LLM-assisted curation and automated ODK pipelines to keep a domain ontology current as AI concepts and ethical concerns evolve Joachimiak et al. [2025]. Such approaches highlight the

importance of distinguishing between evolving domain-level ontologies and the comparatively stable substrates on which they depend: the present result explains why neutrality constraints must apply to the latter even as the former necessarily change.

By grounding this constraint in the Method of Levels of Abstraction, we move the debate from a sociological discussion of agreement to a formal requirement for observational invariance.

This result is complementary to prior work rather than competitive. Upper ontologies may inform the categorical structure of a neutral substrate. Legal and causal frameworks may operate as interpretive layers atop it. What the present work provides is a principled boundary: a specification of what must be externalized in order for the substrate to support accountability across disagreement.

3 Formal Requirements for Ontological Neutrality

The notion of neutrality used in this paper is deliberately narrow and operational. It is not intended to capture moral neutrality, political impartiality, or epistemic skepticism in a general sense. Rather, neutrality is defined with respect to the functional role an ontology is expected to play in explanation and accountability systems: serving as a shared substrate across divergent interpretive frameworks.

An ontological substrate is neutral, in the sense relevant here, if it satisfies two requirements. These requirements are independent but jointly necessary. Together, they characterize the minimal conditions under which a shared ontology can support accountability without foreclosing disagreement.

Throughout this section, all requirements are understood as analytic consequences of this role-relative definition of neutrality, not as general design prescriptions for ontologies.

Interpretive non-commitment constrains what the substrate asserts at its chosen Level of Abstraction. Extension stability is a global consistency condition: even a substrate that is silent on contested predicates can fail neutrality if it encodes background axioms that conflict with some admissible interpretive framework.

3.1 Interpretive Non-Commitment

The first requirement, under this definition of neutrality, is interpretive non-commitment. An ontology satisfies this requirement if it does not assert conclusions whose truth values vary across admissible interpretive frameworks.

Admissibility is determined by the domain of application, not by the substrate. A framework is admissible if recognized stakeholders in the domain accept it as a legitimate interpretive stance, for example, a jurisdiction's legal code, a scientific community's causal methodology, or an institution's normative charter. The substrate must accommodate all such frameworks; it does not adjudicate among them.

Definition 3.1 (Admissible Framework)**.** A framework $\mathcal{F}$ is *admissible* if it is internally consistent ($\mathcal{F} \nvdash \bot$) and represents a legitimate interpretive stance within the domain of application. The set of all admissible frameworks is denoted $\mathbb{F}$. Admissible frameworks need not be mutually compatible.

With this notion in hand, we can state the first requirement precisely.

Definition 3.2 (Framework-Variant Proposition)**.** A proposition p is *framework-variant* if there exist admissible frameworks $\mathcal{F}_1, \mathcal{F}_2 \in \mathbb{F}$ such that $\mathcal{S} \cup \mathcal{F}_1 \vdash p$ and $\mathcal{S} \cup \mathcal{F}_2 \vdash \neg p$.

Definition 3.3 (Interpretive Non-Commitment)**.** An ontology $\mathcal{S}$ satisfies *interpretive non-commitment* if there is no proposition p such that $\mathcal{S} \vdash p$ and the truth of p varies across admissible interpretive frameworks.

Accountability systems routinely involve disagreements about what occurred, why it occurred, and how it should be evaluated. Legal frameworks may disagree about whether an action was permitted or prohibited; analytic frameworks may disagree about whether one event caused another; political frameworks may disagree about responsibility or intent. These disagreements are not merely epistemic gaps to be filled with additional data. They reflect differences in background assumptions, governing rules, and interpretive commitments.

A neutral substrate, under this definition, must therefore refrain from settling such questions at the ontological level. If an ontology asserts that a particular action was obligatory, forbidden, or permitted, it necessarily privileges one normative framework over others. Similarly, if it asserts that one event caused another, it privileges a particular causal model or explanatory framework. In both cases, the ontology ceases to be neutral with respect to interpretation.

Interpretive non-commitment does not require the ontology to ignore normative or causal discourse altogether. Rather, it requires that the substrate operate at a Level of Abstraction (LoA) Floridi [2008, 2011] that excludes explanatory or evaluative observables. In this framework, an LoA consists of a set of observables; neutrality is achieved by selecting an LoA where the observables are restricted to entity existence and identity conditions (i.e., what entities exist and how they are individuated).

These observables constitute the invariant core of the representation, remaining valid regardless of the higher-level interpretive logic applied to them. Claims about obligations, permissions, or causation are thus represented as external assertions made by agents within an interpretive framework, rather than being internalized as substrate-layer facts.

3.2 Extension Stability

The second requirement, given the neutrality role defined above, is extension stability. An ontology satisfies this requirement if it remains consistent when

extended by incompatible interpretive frameworks.

Definition 3.4 (Extension Stability)**.** An ontology $\mathcal{S}$ satisfies *extension stability* if for all admissible frameworks $\mathcal{F} \in \mathbb{F}$, $\mathcal{S} \cup \mathcal{F} \nvdash \bot$.

Extension stability does not require that all admissible interpretive frameworks be simultaneously combined into a single, globally consistent theory. Rather, the requirement is *pairwise compatibility with the substrate*: for each admissible framework $\mathcal{F} \in \mathbb{F}$ considered independently, the combined theory $\mathcal{S} \cup \mathcal{F}$ must remain consistent. The substrate is permitted to be extended by additional structures, records, or interpretive layers, provided such extensions do not retract, revise, or contradict substrate-layer assertions. A violation occurs only when accommodating a new admissible framework requires modification of the substrate itself. Disagreement between frameworks, including disagreement about causal, normative, or explanatory conclusions, is expected and permitted; what is prohibited is embedding commitments at the substrate layer that force revision when such disagreement arises.

In practice, data systems are not static. New legal interpretations emerge, analytic models are revised, and political judgments are contested and overturned. A neutral substrate, in order to satisfy extension stability, must be able to accommodate such changes without requiring revision of its foundational commitments. Interpretive disagreement should result in additional structure layered atop the substrate, not in modification of the substrate itself.

Extension stability is violated when the introduction of a new interpretive framework requires retracting or revising ontological assertions.

Consider a substrate $\mathcal{S}$ used by two interpretive frameworks, $\mathcal{F}_1$ and $\mathcal{F}_2$, that contradict each other ($\mathcal{F}_1 \cup \mathcal{F}_2 \vdash \bot$). For $\mathcal{S}$ to remain stable, it must be separately consistent with each framework: $\mathcal{S} \cup \mathcal{F}_1 \nvdash \bot$ and $\mathcal{S} \cup \mathcal{F}_2 \nvdash \bot$. The substrate need not reconcile the frameworks with each other; it must simply avoid assertions that either framework rejects.

Now suppose $\mathcal{S}$ embeds a causal or normative conclusion c that $\mathcal{F}_1$ accepts

but $\mathcal{F}_2$ rejects (i.e., $\mathcal{F}_2 \vdash \neg c$). Then $\mathcal{S} \cup \mathcal{F}_2 \vdash c \wedge \neg c \vdash \bot$: the combination is inconsistent, and $\mathcal{S}$ must be revised.

This demonstrates that embedding any causal or deontic conclusion, regardless of current consensus, introduces latent instability. Such a substrate cannot function as a permanent neutral foundation, because some admissible framework may eventually reject what the substrate asserts.

This requirement rules out approaches in which neutrality is achieved through periodic revision or replacement of ontological commitments. Stability under extension is a necessary condition for interoperability across time, jurisdictions, and analytic communities.

This property is sometimes called *monotonicity*: the substrate grows by addition of interpretive layers, never by retraction of foundational assertions.

3.3 Scope of Neutrality

It is important to emphasize that neutrality, as defined here, is not global. A neutral ontology is not neutral with respect to existence, identity, or classification. It must take substantive positions on what kinds of entities exist, how they are distinguished, and what criteria govern their persistence. These commitments are necessary for accountability and do not vary across interpretive frameworks in the same way that causal or normative conclusions do. Unless otherwise noted, all entailment is with respect to classical first-order logic with equality.

Neutrality is therefore scoped specifically to interpretive commitments: those aspects of representation whose truth depends on legal, normative, causal, or analytic frameworks that may legitimately disagree. The exclusion of such commitments from the substrate is not a matter of preference or conservatism; it is a functional requirement derived from the role the ontology is intended to play as a neutral substrate.

The design of a neutral substrate requires distinguishing between the Level of

Abstraction (LoA) and the Level of Organization (LoO) as referenced above. While the LoA determines the set of available observables (e.g., excluding causal predicates), the LoO characterizes the architectural hierarchy of the system.

A further scope condition applies. The neutrality requirements assume that entity existence and identity conditions are themselves invariant across admissible frameworks. If frameworks disagree about identity, for example, whether two references denote the same actor, or whether a particular institutional artifact exists, then the substrate cannot be neutral with respect to those frameworks. In such cases, identity must be resolved at a prior stage, or the domain does not admit a neutral substrate in the sense defined here. This is not a defect of the framework but a boundary condition: neutrality presupposes a shared ontological ground on which interpretation can vary.

We propose that the neutral substrate occupies the primary LoO, providing the raw entity and identity conditions upon which higher-level, interpretive LoOs are organized. This ordering reflects the direction of dependence required for neutrality: identity is established at the substrate layer before any interpretive framework is applied. Explanation and interpretation operate on entities whose existence and identity are already fixed. This ensures that changes in higher-level organizational logic do not propagate downward to corrupt the foundational substrate.

Together, interpretive non-commitment and extension stability define the functional boundaries of a neutral substrate. These requirements establish that neutrality is not a lack of content, but a categorical constraint: to remain stable under pluralistic interpretation, a foundational ontology must be strictly pre-causal and pre-normative. In the next section, we provide a formal impossibility argument showing why any violation of these categorical exclusions renders a substrate inherently non-neutral.

4 The Impossibility of Causal and Normative Substrates

This section shows that the neutrality requirements defined in Section 3 are incompatible with embedding causal or normative commitments at the ontological substrate layer. The argument is structural rather than empirical: it does not depend on particular domains, datasets, or historical cases, but on the logical relationship between interpretive disagreement and ontological assertion. All necessity and impossibility claims in this section are relative to those requirements.

4.1 Neutrality as Invariance Across LoAs

Recall that a neutral ontological substrate, by definition, must be compatible with multiple admissible interpretive frameworks, even when those frameworks disagree. Compatibility here is understood in a strong sense: the same substrate must remain logically consistent when extended by divergent interpretive frameworks, without revision or retraction of substrate-layer assertions.

A framework is *admissible* if it is internally consistent and represents a legitimate interpretive stance within the domain of application, for example, a recognized legal jurisdiction, an established causal modeling tradition, or a coherent normative theory. Admissibility is not universality: admissible frameworks may contradict one another, as when two jurisdictions reach opposite legal conclusions or two causal models attribute responsibility differently. The set of admissible frameworks $\mathbb{F}$ is thus characterized by internal consistency, not mutual compatibility.

This neutrality requirement immediately constrains the Level of Abstraction (LoA) at which the substrate, under the neutrality definition, must operate. For a substrate to be neutral, its set of observables must be restricted to those that are invariant across all admissible interpretive frameworks. Any

ontological commitment that introduces a higher-level observable, in particular one requiring causal or normative attribution, collapses the pluralism of the system into a single, privileged framework, thereby violating interpretive non-commitment.

4.2 Normative Commitments and Interpretive Incompatibility

Normative statements, i.e., claims about obligation, permission, prohibition, or violation, are inherently framework-relative. Their truth depends on legal regimes, institutional authorities, temporal scope, and interpretive stance. It is therefore a routine and expected feature of accountability systems that admissible frameworks disagree about normative conclusions.

Suppose an ontology asserts a normative conclusion at the substrate layer, such as that a particular action was prohibited or that an obligation applied to a given actor. By doing so, the ontology privileges one normative framework over others. Any framework that denies the asserted conclusion becomes incompatible with the substrate, as it cannot be layered atop it without contradiction or revision.

This incompatibility is not a matter of missing context or insufficient detail. It arises from the ontological act of asserting a contested normative conclusion as a fact. As a result, no ontology that embeds normative commitments at the foundational layer can, under the neutrality requirements, satisfy interpretive non-commitment. Moreover, when alternative normative interpretations arise, as they inevitably do, the substrate must be revised to restore consistency, thereby violating extension stability.

4.3 Causal Commitments and Model Dependence

Causal statements exhibit the same structural problem, despite their different surface form. Claims such as *event A caused event B* depend on background

assumptions about causal mechanisms, variable selection, counterfactual reasoning, and model scope. Distinct causal frameworks may be equally admissible while disagreeing about specific causal relationships.

If an ontology asserts causal relations at the substrate layer, it necessarily commits to one causal model among many. Frameworks that reject that model, or that attribute causation differently, cannot be layered onto the substrate without conflict. As with normative commitments, the ontology ceases to be interpretively neutral and, under the extension stability requirement, cannot remain stable under extension.

Importantly, this argument does not rely on the presence of an active dispute over a specific event. Rather, it identifies causation as a category-type error for a neutral substrate. Because causal attribution is inherently model-dependent, its inclusion in the foundational layer constitutes a structural commitment to a specific counterfactual or mechanistic logic. As soon as an ontology asserts $A \rightarrow B$ as a causal fact, it excludes any framework that treats A and B as merely correlated or as having a common cause Z. Therefore, under the neutrality requirements, the substrate must be strictly pre-causal: by treating a causal attribution, a function of an interpretive model, as an ontological primitive, the ontology conflates the object of observation with its explanatory evaluation.

To be clear, *pre-causal does not mean acausal* (i.e., causation-denying). The substrate does not deny that causation exists or that causal reasoning is valuable. Rather, it refrains from embedding causal conclusions as foundational facts, reserving causal attribution for interpretive layers where framework assumptions are explicit and disagreement is representable. Causation is externalized, not eliminated.

4.4 Reification Does Not Eliminate the Problem

One might attempt to preserve neutrality by reifying causal or normative statements, representing them as claims, reports, or assertions rather than

as direct ontological facts. This move is necessary but not sufficient.

Reification allows the ontology to represent discourse about the world without asserting conclusions about the world itself. This strategy aligns with recent arguments for epistemic ontologies that represent knowledge about the world rather than the world directly Kassel [2023]. For example, an ontology may represent that an agent asserted that event A caused event B without asserting the causal relation $A \rightarrow B$ as a substrate-layer fact. In this way, reified claims are treated as entities available for interpretation, comparison, or evaluation, rather than as ontological commitments.

Reification preserves interpretive non-commitment only if the ontology refrains from simultaneously asserting the reified content as a substrate-layer truth. If causal or normative relations are both asserted as facts and reified as claims, neutrality is already lost. If they are represented solely as claims, then they no longer function as ontological commitments but as objects of discourse layered atop the substrate.

Thus, reification does not provide a middle ground in which causal or normative conclusions can be embedded without consequence. It either externalizes interpretation, consistent with pre-causal and pre-normative design, or it leaves the original incompatibility intact.

4.5 The Ontological Neutrality Theorem

The preceding observations yield the central result of this paper.

Theorem 4.1 (Ontological Neutrality Theorem)**.** *Let $\mathcal{S}$ be an ontology intended to function as a neutral substrate across diverse interpretive frameworks, and let $\mathbb{F}$ be the set of admissible interpretive frameworks. Then $\mathcal{S}$ satisfies the requirements of neutrality (interpretive non-commitment and extension stability) if and only if its foundational Level of Abstraction excludes causal and normative primitives.*

Proof. **(Only if.)** Suppose $\mathcal{S}$ contains a causal or deontic primitive p. By the

definition of neutrality (Section 3), $\mathcal{S}$ must satisfy: for all $\mathcal{F} \in \mathbb{F}$, $\mathcal{S} \cup \mathcal{F} \nvdash \bot$.

Causal and normative primitives are framework-dependent: there exist admissible frameworks $\mathcal{F}_1, \mathcal{F}_2 \in \mathbb{F}$ such that $\mathcal{F}_1 \vdash p$ and $\mathcal{F}_2 \vdash \neg p$.

Then $\mathcal{S} \cup \mathcal{F}_2 \vdash p \wedge \neg p \vdash \bot$. To restore consistency, either:

(i) $\mathcal{F}_i$ must be excluded from $\mathbb{F}$, violating interpretive non-commitment; or

(ii) $\mathcal{S}$ must be revised to remove p, violating extension stability.

In either case, $\mathcal{S}$ fails to satisfy neutrality.

(If.) Suppose $\mathcal{S}$ excludes all causal and normative primitives, representing only entities and identity conditions. Under this setup, such observables are invariant across admissible frameworks: frameworks may disagree about why an entity exists or what it means, but not about the substrate-layer fact of its existence and identity. Thus, for all $\mathcal{F} \in \mathbb{F}$, $\mathcal{S} \cup \mathcal{F}$ introduces no contradiction, satisfying both interpretive non-commitment and extension stability.

Scope note. This direction assumes that entity existence and identity conditions are not themselves contested across admissible frameworks. In domains where identity is interpretively contested, for example, where frameworks disagree about whether two records denote the same entity, or whether a particular kind of entity exists at all, the substrate, under the neutrality definition, cannot be neutral until identity conditions are resolved. Such resolution is a precondition for neutrality, not a product of it. The theorem applies to domains where identity can be fixed prior to interpretive extension; it does not claim that all domains admit neutral substrates. □

This result is not contingent on particular modeling choices or domain assumptions. It follows directly from the functional role the substrate is required

to play under the neutrality definition. Neutrality across disagreement and embedded interpretive commitments are structurally incompatible.

In the next section, we consider the implications of this result for ontology design, clarifying what must be excluded from foundational layers and how interpretation, evaluation, and explanation may be externalized without loss of accountability.

5 Implications for Ontology Design

The impossibility result established in Section 4 does not prescribe a particular ontology. Rather, it constrains the design space of any ontology intended to function as a neutral substrate for accountability. This section clarifies what such constraints require, what they exclude, and how interpretation and evaluation may be accommodated without violating neutrality.

5.1 What Must Be Excluded from the Substrate

The primary implication is negative but precise. A neutral ontological substrate must exclude, at the foundational level, any assertions that entail propositions whose truth values vary across admissible frameworks. In particular, the substrate must not embed:

- normative conclusions, such as obligations, permissions, prohibitions, violations, or compliance determinations;
- causal conclusions, such as assertions that one event caused, produced, or was responsible for another;
- evaluative judgments that privilege one legal, political, or analytic stance over others.

These exclusions do not deny the importance of such concepts for accountability. Rather, they recognize that embedding them as ontological facts

collapses the distinction between representation and interpretation, undermining neutrality.

The exclusions apply specifically to asserted conclusions, not to the entities or structures that such conclusions refer to. Actors, events, institutional artifacts, jurisdictions, and records may all be represented without committing to how they are interpreted or evaluated. The substrate may therefore be rich in entities and identity structure while remaining silent on contested interpretations.

5.2 What the Substrate Must Provide

Although the constraints are restrictive, they do not leave the ontology impoverished. On the contrary, a neutral substrate must make strong, explicit commitments in areas that are invariant across interpretive frameworks. In terms of the Method of Levels of Abstraction (LoA) Floridi [2008], the substrate defines the set of *invariant observables*: data points that remain constant regardless of the explanatory logic applied to them.

The claim that a neutral substrate relies on invariant observables does not assert that all questions of entity individuation, persistence, or boundary demarcation are framework-independent. Many such questions, e.g., the spatial or temporal granularity of an event, the criteria for organizational continuity, or the recognition of informal institutions, are legitimately contested across admissible frameworks. Neutrality instead requires that the substrate fix only a minimal and domain-appropriate set of identity and persistence conditions sufficient to support accountability relations, while deferring finer-grained individuation disputes to interpretive layers. These substrate-layer commitments are invariant not because they resolve all ontological disagreement, but because they remain stable under extension by mutually incompatible causal, legal, or normative frameworks.

In particular, the substrate must provide:

- stable reference to entities that participate in accountability relationships;
- clear identity criteria and disjointness conditions for those entities;
- persistence conditions that allow entities to be tracked across time, jurisdictions, and datasets.

These commitments are not optional. Accountability depends on the ability to refer unambiguously to who acted, what occurred, which institutional instruments existed, and within what jurisdictional scope. Such commitments do not vary with interpretive stance in the way causal or normative conclusions do, and therefore do not threaten neutrality.

5.3 Externalizing Interpretation Without Loss

A common concern is that excluding causal and normative commitments from the substrate renders the ontology incapable of supporting explanation, evaluation, or judgment. The impossibility result shows that the opposite is true: such functions must be externalized in order to be supported robustly.

Interpretation is accommodated by organizing the system into distinct Levels of Organization (LoO) Floridi [2011]. The foundational LoO (the substrate) records the what (entities and identity), while higher-order LoOs record the how and why (interpretive claims). By maintaining this structural separation, we allow multiple, mutually inconsistent interpretive LoOs to reside atop the same foundational LoO without triggering logical collapse. Disagreement, revision, and contestation are then represented by the coexistence of multiple such records, rather than by revision of substrate-layer facts.

Similarly, causal and normative reasoning may be carried out within interpretive frameworks layered atop the substrate. These frameworks may draw on the same underlying entities and events while reaching incompatible conclusions. The substrate remains unchanged, serving as a stable point of reference rather than a site of resolution. This architecture does not diminish

the importance of causal reasoning; it locates causation where it belongs: in interpretive layers where model commitments are visible and contestable.

5.4 Permitted Structural Relations and Excluded Commitments

The exclusion of causal and normative primitives does not entail the exclusion of all structured relations. A neutral substrate permits relations that establish structural, temporal, or institutional linkage without asserting causal efficacy or evaluative force. Relations such as containment, delegation, authorization, temporal occurrence, participation, and applicability are admissible insofar as they do not assert that one entity caused, justified, or obligated another. By contrast, relations that embed causal attribution (e.g., X caused Y) or deontic judgment (e.g., X violated Y, X was obligated to do Y) are excluded from the substrate and must be represented, if at all, via reification or within interpretive frameworks. The neutrality boundary is thus drawn not at the presence of structure, but at the embedding of framework-dependent conclusions as ontological facts.

5.5 Reification as a Boundary Mechanism

Reification plays a critical role in enforcing the boundary between substrate and interpretation. By treating claims, reports, and assertions as entities in their own right, the ontology can represent discourse about the world without asserting conclusions about the world itself.

However, reification functions as a boundary mechanism only when applied consistently. If causal or normative relations are asserted as substrate-layer facts and merely duplicated as reified claims, neutrality is not preserved. Reification supports neutrality only when the substrate refrains entirely from endorsing the reified content.

Properly implemented, reification transforms a framework-dependent pred-

icate (e.g., $caused(A, B)$) into an entity (e.g., $Assertion72$). This shift in type allows the substrate to maintain its identity-centric LoA while providing the raw materials for higher-level LoOs to perform their evaluative functions.

This observation reinforces the central conclusion: neutrality is not achieved by representational cleverness alone, but by disciplined exclusion of interpretive commitments from the foundational layer.

5.6 Summary of Design Constraints

The implications of the impossibility result can be summarized succinctly. Any ontology intended to serve as a neutral substrate for accountability must:

- restrict the foundational LoA to invariant observables (entities and identity conditions) while excluding interpretive predicates;
- prohibit the assertion of causal and normative conclusions as substrate-layer facts;
- preserve the LoO hierarchy to support interpretation, evaluation, and explanation exclusively through externalized, higher-level organizational layers;
- maintain monotonicity by remaining stable and unrevised under the addition of mutually incompatible interpretive frameworks.

These constraints do not define an ontology, but they sharply delimit what any such ontology can be.[1] In the following section, we conclude by situating these constraints as boundary conditions on any ontology intended to function as a neutral substrate for accountability, independent of domain or application.

[1] For illustration, consider a substrate that asserts *Agent A's action caused Outcome B*. Under Framework $\mathcal{F}_1$ (a proximate-cause legal standard), this holds. Under Framework $\mathcal{F}_2$ (a but-for counterfactual model), it does not. The substrate must be revised to accommodate $\mathcal{F}_2$, violating extension stability. A pre-causal substrate would represent Agent A, the action, and Outcome B as entities, leaving causal attribution to the interpretive layer.

6 Conclusion

This paper has argued that ontological neutrality, when understood as interpretive non-commitment and stability under incompatible extensions, imposes strict and unavoidable constraints on the design of ontological substrates. By applying the Method of Levels of Abstraction (LoA), we have demonstrated that any ontology intended to function as a shared foundation for accountability across disagreement must be pre-causal and pre-normative.

The argument is structural rather than empirical. When causal or normative conclusions are asserted as substrate-layer facts, neutrality is lost: incompatible interpretive frameworks can no longer coexist without revision or contradiction. This incompatibility arises not from disagreement itself, but from the Level of Organization (LoO) at which contested commitments are embedded. It can be resolved only by externalizing interpretation to higher organizational layers that depend on, but do not revise, the substrate.

The resulting design constraints are both restrictive and enabling. They restrict what may be asserted at the foundational layer, but they enable accountability by preserving stable reference to entities and identity conditions across time and interpretive change. Interpretation and explanation are not eliminated; they are relocated to layers where disagreement can be represented explicitly rather than suppressed through premature ontological commitment.

At the same time, the impossibility result established here is conditional rather than universal. Neutral substrates are achievable only in domains where entity existence and identity conditions can be fixed prior to interpretive extension. Where identity itself remains irreducibly contested, neutrality is not merely difficult but unattainable: the substrate cannot be stabilized without already privileging one interpretive stance. This limitation is not a defect of the framework, but an explicit boundary condition on its applicability.

Taken together, these results clarify both the power and the limits of ontological neutrality. They establish a necessary condition that any ontology

intended to function as a neutral substrate must satisfy, while also identifying the domain features that make such neutrality possible. By making these constraints explicit, the paper delineates the space within which ontological representations can remain neutral in the presence of persistent interpretive disagreement across institutional and analytic contexts.

This paper is deliberately meta-theoretical: it establishes necessary constraints without instantiating a particular ontology. Concrete examples would introduce domain commitments that compromise the generality of the result. Demonstrating how these constraints apply to specific domains, including the design of neutral substrates for accountability and legal interoperability, is an important direction for future work. Exploring how existing upper ontologies might be profiled or extended to satisfy these constraints offers a promising path toward practical neutral substrates.

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Statements and Declarations

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The author was solely responsible for the conception, analysis, and writing of this manuscript.

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Appendix A. Glossary of Terms

This appendix defines key terms used throughout the paper.

Core Ontology Concepts

Applied Ontology

The use of ontological methods to structure and analyze real-world domains for practical purposes.

Boundary Condition

A precondition that must hold for a framework or result to apply. In this paper, the central boundary condition is that entity existence and identity conditions must be invariant across admissible frameworks within the domain. Domains where identity is itself contested do not admit neutral substrates in the sense defined here. Boundary conditions delimit scope; they are not defects but explicit constraints on applicability.

Embedding

The act of asserting a claim as a foundational fact within an ontology, such that it becomes part of the substrate-layer representation. Embedded content is treated as true by the ontology itself, not merely recorded as a claim made by some agent. Contrast with *Reification*.

Epistemic Ontology

Ontologies that represent knowledge about the world rather than the world directly. Epistemic ontologies encode claims, beliefs, or assertions as reified entities, allowing representation of diverse perspectives without embedding contested conclusions as substrate-layer commitments. Contrast with *Metaphysical Ontology*.

Existence Conditions

The criteria that determine whether an entity is present in a domain.

Existence conditions specify what must hold for an entity to be recognized by the ontology, independent of how it is interpreted or evaluated.

Identity Conditions

The criteria that determine when two references denote the same entity, and what changes an entity can undergo while remaining the same entity. Identity conditions establish persistence and individuation prior to interpretive or causal analysis.

Level of Abstraction (LoA)

A perspective defined by a specific set of observables used to represent and analyze a domain. The LoA determines what can be seen or queried; selecting a restricted LoA excludes certain predicates from the representation.

Level of Organization (LoO)

The architectural layer or scale at which entities and relationships are modeled within a system. Levels of Organization are structural rather than scalar: they differ by direction of dependence (e.g., foundational versus interpretive), not by degree, granularity, or complexity. A system may have multiple LoOs arranged hierarchically, with foundational layers supporting higher-order interpretive layers.

Metaphysical Ontology

An ontology that represents the world directly, asserting what exists and what relations hold as ontological facts. Metaphysical ontologies embed commitments about the structure of reality at the substrate layer. Contrast with *Epistemic Ontology*.

Observables

The set of properties, relations, or predicates that an ontology makes available for representation and query. An ontology's Level of Abstraction is defined by its observables; neutrality requires restricting observables to those invariant across admissible frameworks.

Ontological Assertion

A statement embedded in an ontology as a foundational fact. Ontological assertions carry ontological commitment: they represent the ontology's position on what exists or holds, not merely what has been claimed by external agents.

Ontology

A formal representation of entities within a domain and the relationships that hold between them, expressed in a logic or schema suitable for inference.

Reification

The representation of a claim, assertion, or relation as an entity rather than as a direct ontological fact. Reification allows the ontology to represent discourse about the world without asserting conclusions about the world itself, for example, by representing that an agent asserted a causal or normative claim without embedding that claim as a substrate-layer fact. See also *Epistemic Ontology*. Contrast with *Embedding*.

Representation

The encoding of information within an ontology. Representation is broader than embedding: an ontology may represent a claim (via reification) without embedding it as a foundational fact. See also *Embedding*, *Reification*.

Substrate

The foundational layer of an ontology, consisting of entities, identity conditions, and persistence criteria. A neutral substrate excludes causal and normative primitives, serving as a stable base for divergent interpretive layers. Also called *substrate layer* or *foundational layer*.

Neutrality and Interpretation

Accountability System

A data system designed to support explanation, evaluation, and assignment of responsibility across multiple stakeholders. Accountability systems must accommodate persistent disagreement about causes, obligations, and interpretations.

Admissible Framework

An interpretive framework that is internally consistent and represents a legitimate stance within the domain of application, such as a recognized legal jurisdiction, an established causal modeling tradition, or a coherent normative theory. Admissible frameworks need not be mutually compatible.

Commitment

An ontological stance that asserts certain facts, relations, or classifications as true at the substrate layer. Commitments constrain what interpretive frameworks can be layered atop the ontology without contradiction.

Compatibility

The property of an ontology and an interpretive framework such that their combination does not entail contradiction. Formally: $\mathcal{S} \cup \mathcal{F} \nvdash \bot$.

Consistency ($\nvdash \bot$)

The property of a set of statements such that no contradiction can be derived from its assertions. The notation $\mathcal{S} \nvdash \bot$ indicates that an ontology $\mathcal{S}$ is consistent; $\mathcal{S} \vdash \bot$ indicates that $\mathcal{S}$ is inconsistent (i.e., both p and $\neg p$ can be derived for some proposition p).

Extension Stability

The requirement that a substrate remain logically consistent when extended by admissible, including mutually incompatible, interpretive frameworks. Violation occurs when adding a framework forces

revision of substrate-layer assertions. Together with *Interpretive Non-Commitment*, defines *Neutrality*.

Interpretive Framework

A coherent set of principles, rules, or assumptions used to evaluate, explain, or assign meaning to entities and events. Examples include legal jurisdictions, causal models, ethical theories, and analytic methodologies. Interpretive frameworks may disagree with one another while each remaining internally consistent.

Interpretive Non-Commitment

The requirement that a substrate refrain from asserting conclusions whose truth varies across admissible interpretive frameworks. An ontology satisfies interpretive non-commitment if it does not privilege one framework's conclusions over another's. Together with *Extension Stability*, defines *Neutrality*.

Neutral Substrate

A foundational ontology that satisfies neutrality, enabling stable use across multiple, potentially incompatible interpretive frameworks. A neutral substrate excludes causal and normative commitments at the foundational layer, supporting pluralism and accountability.

Neutrality

The property of an ontology that avoids embedding causal, deontic, or normative commitments at the foundational layer, enabling stable use across persistent interpretive, legal, and analytic disagreement. Neutrality is defined by two requirements: interpretive non-commitment and extension stability.

Pluralism

The coexistence of multiple, potentially incompatible interpretive frameworks within a single system. A neutral substrate supports pluralism by providing a shared foundation that does not privilege any single framework.

Pluralism Collapse

The loss of pluralism that occurs when an ontology embeds commitments that exclude one or more admissible frameworks. Pluralism collapse reduces the system to a single privileged interpretation.

Causal and Normative Concepts

Causal Commitment

An ontological commitment that asserts causal relations (e.g., A caused B) as foundational facts. Causal commitments are model-dependent and vary across admissible causal frameworks.

Deontic Commitment

An ontological commitment to obligations, permissions, prohibitions, or duties as foundational facts. Deontic commitments specify what ought to be done, not merely what exists or occurs.

Framework-Dependent

A property of claims or predicates whose truth value varies across admissible interpretive frameworks. Causal and normative claims are framework-dependent; entity existence and identity conditions are not.

Normative Commitment

An ontological commitment that encodes evaluative, legal, moral, or policy-based judgments as part of the foundational representation. Normative commitments may be ethical, legal, institutional, or procedural, and are actor- or framework-relative.

Pre-Causal

The property of an ontology that excludes causal primitives from its foundational layer. Pre-causal does not mean acausal or causation-denying; it means *prior to causal attribution*. A pre-causal substrate represents entities and events without asserting causal relations between them, allowing causal reasoning to occur in interpretive

layers where model assumptions are explicit and disagreement is representable. Causation is externalized, not eliminated.

Pre-Normative

The property of an ontology that excludes normative primitives from its foundational layer. A pre-normative ontology represents entities and actions without asserting obligations, permissions, or evaluations.

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