

## Relationality in Empirical Inquiry

### Empirical Appraisal, Imperfect Detection, and Bounded Tests of Relational Constitution

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*Distinct, but not separate. Measured pathways, real boundaries, open tests.*

#### PUBLIC RESEARCH-SOURCE WORKING PAPER

#### Core status statement

This paper is a conceptual methods paper and research program. It does not report a systematic review, a completed relational census, or an experiment demonstrating universal relationality. It distinguishes empirical discriminability, directional evidence, incremental confirmation, and decision-grade confirmation; separates latent relation status from imperfect detection; and defines bounded estimands whose meaning is indexed to a declared sampling frame, taxonomy, threshold, observation protocol, and search budget.

#### Abstract

The statement “everything is interconnected” is too ambiguous to serve as a scientific hypothesis. It may denote evidential accessibility, directed causal influence, common-cause dependence, shared history, constitutive structure, functional dependency, exchange, statistical association, ecological coupling, or inclusion in one reality. These relations have different truth conditions and cannot be pooled without loss of meaning.

This paper proposes a seven-row claim architecture comprising six primary claims plus an explicit B-U row. A, the Empirical Appraisal Condition, separates four distinctions: an observation protocol may make alternatives discriminable; a realized record may provide directional evidence and incremental confirmation; and decision-grade confirmation requires a declared evidential or decision rule. None of these establishes a material relation independent of the observation process. B, Operational Relational Prevalence, distinguishes latent relation status from observed detection and requires studies to report operational detection prevalence unless sensitivity and false-positive processes are identified or bounded. Exact universality is divided into finite-frame, counterexample, and superpopulation forms. Each universal must declare whether it concerns protocol classifications or latent relation status: adequate operational negatives directly refute the matching operational universal, while rejection of a latent universal remains governed by the declared classification-error model. Near-universality is treated as a preregistered threshold claim rather than inferred from an all-positive finite sample. C, unrestricted present-horizon pairwise causal reachability, is contradicted in its strong form by relativistic causal structure; only domain- and horizon-bounded variants remain open. D, totality inclusion, is logical or definitional. E,

Relational Union, is abductive philosophy. F, ontological unboundedness or AIU-O, is an open existential hypothesis not entailed by mathematics or A–B. A specified subclaim that names one allegedly unbounded respect may be testable; the general claim that at least one unbounded respect exists is harder to exhaustively refute.

A qualifying relation must satisfy relation-family-specific criteria. Historical, constitutive, and present-horizon relations are reported separately. Classification uncertainty, measurement error, sampling uncertainty, design sensitivity, model uncertainty, verified-frame ascertainment, and search-budget dependence are not collapsed into one interval. The paper proposes bounded censuses, counterexample searches, complexity-controlled model comparisons, and a governance-omission experiment. It supplies an empirical and methodological base, not a deduction of ethics from physics.

**Keywords:** empirical appraisal; relationality; imperfect detection; partial identification; construct validity; causal reachability; relational prevalence; falsifiability.

**AI-use disclosure:** Generative AI systems assisted with literature organization, language-drafting alternatives, formatting and artifact production, and adversarial error-checking under the author's direction. The author originated the research program, determined the final conceptual architecture and conclusions, reviewed the complete manuscript, and accepts responsibility for every claim.

## 1. Why this paper stands alone

A single document can discuss relational science, ontological union, Union-Based Ethics, SGP, and MathGov. It cannot validate them by one method. Measurement conditions, empirical generalizations, metaphysical interpretations, normative commitments, and governance-performance claims occupy different epistemic registers. Combining them creates authority leakage: a secure claim about measurement can make a speculative claim about total reality feel equally secure.

This paper asks four questions:

- What does empirical appraisal establish about relation?
- What substantive relational quantities can be estimated rather than asserted?
- What operational hypotheses are genuinely exposed to loss?
- What evidence would narrow or reject those hypotheses?

The ethical and civilizational implications belong in the companion paper, *From Relationality to Union-Based Ethics*.

## 2. Contribution and novelty

The proposition that measurement and empirical inquiry are relational is not a new discovery. Information theory and causal inference formalize dependencies among systems, variables, interventions, hypotheses, and records [1–3]; construct-validation and confirmation traditions likewise treat evidential authority as model- and inference-dependent [4–5, 26]. The contribution here is an integrated claim-authority and operational research program:

- a seven-row architecture separating six primary claims and the explicit B-U universal row commonly collapsed into “oneness”;
- a distinction among empirical discriminability, directional evidence, incremental confirmation, and decision-grade confirmation;
- a separation between latent relation status and imperfect observed detection;
- bounded estimands that can return values below one rather than forcing universality;
- relation-class-specific materiality criteria instead of one artificial common unit;
- construct-validity safeguards against circularity and relation inflation;
- preregistered tests with detection models, controls, classification bounds, sensitivity analyses, and stopping rules;
- a bridge to comparative governance studies without treating governance effectiveness as already established.

The paper should therefore be assessed as a conceptual methods contribution, not as a completed census of reality.

## 3. Definitions

### 3.1 Entity

An entity is a provisionally distinguished object, event, process, field configuration, organism, institution, or system within a declared inquiry. Distinction is real and methodologically necessary. A person is not a river. A molecule is not an organization. Relational analysis does not erase types or boundaries.

#### 3.1.1 Entity individuation and sampling rules

Entity construction is part of the measurement instrument, not a neutral preliminary. Before any relation search, a study must freeze:

- the unit of analysis and the registry or sampling frame from which units are drawn;
- inclusion and exclusion criteria;
- spatial, temporal, functional, and jurisdictional boundaries;
- identity and persistence rules across time;
- whether parts and wholes may both enter the same sample;
- duplicate and near-duplicate handling;
- the independent verification standard for each entity type;
- the treatment of uncertain, composite, disputed, or changing entities;
- sensitivity analyses under alternative defensible individuation rules.

Sampling frames should not be defined by the presence of the relation being measured. Otherwise prevalence can be inflated by construction. When multiple levels are scientifically relevant, they should be analyzed as separate strata rather than pooled without adjustment.

## 3.2 Empirical appraisal

The near-analytic base concerns empirical appraisal, not ontological union. Three stages must be distinguished.

### A1 — Empirical discriminability

Two hypotheses are empirically discriminable under a declared observation protocol  $Q$  when their induced record distributions differ:

$$P_Q(M \mid H_1) \neq P_Q(M \mid H_0).$$

The general necessary-and-sufficient condition is that the induced record distributions are unequal, equivalently that their total-variation distance is positive. Where the relevant absolute-continuity conditions hold, the Kullback-Leibler statement below is an additional necessary-and-sufficient criterion for inequality in that direction:

$$D_{KL}(P_Q(M \mid H_1) \parallel P_Q(M \mid H_0)) > 0.$$

This is a property of the model and observation protocol. It does not say that the record actually obtained favors  $H_1$ .

### A2 — Directional evidence

For a realized record  $m$ , define the log-likelihood ratio:

$$\ell(m) = \log \frac{P_Q(m \mid H_1)}{P_Q(m \mid H_0)}.$$

Then  $\ell(m) > 0$  favors  $H_1$ ,  $\ell(m) < 0$  favors  $H_0$ , and  $\ell(m) = 0$  is evidentially neutral between them. Under a standard incremental Bayesian usage,  $\ell(m) > 0$  can count as incremental confirmation because the record raises the relative support for  $H_1$  [26]. The increase may nevertheless be negligible, fragile, model-sensitive, or wholly insufficient for public claim authority. This is contrastive support for  $H_1$  over  $H_0$ . It constitutes absolute incremental confirmation of  $H_1$  only when the comparison is exhaustive or when the full posterior calculation independently establishes  $P(H_1 \mid m) > P(H_1)$ .

### A3 — Decision-grade confirmation

This research program uses **decision-grade confirmation** for the stronger condition in which evidence satisfies a further preregistered rule appropriate to the purpose, such as a posterior threshold  $P(H_1 \mid m) > \kappa$ , a declared Bayes-factor threshold, controlled error rates, replication, robustness requirements, or a decision criterion. Incremental confirmation does not by itself establish strong evidence, practical importance, replication, robustness, or authorization to act. The decision-grade rule and its error consequences must be declared rather than hidden inside Claim A.

The evidential pathway may be mediated by traces, instruments, shared causes, and background models. The correct general claim is that empirical appraisal requires an observation model under which records can bear differently on alternatives. It does not automatically establish a directed causal arrow or a material relation independent of observation.

### 3.3 Trivial relation

A trivial relation is guaranteed by inquiry itself, such as “was named in this paper” or “was coupled to the measuring apparatus.” It supports Claim A but cannot support Claim B.

### 3.4 Qualifying nontrivial relation

A nontrivial relation must be independently evidenced and must satisfy at least one preregistered criterion within its relation family:

- **Causal or interventional relevance:** changing the relation, under a defensible intervention or natural experiment, changes a declared outcome.
- **Predictive relevance:** removing, masking, or randomizing relation information degrades out-of-sample performance across a prespecified class of adequate models, not merely one convenient model [6].
- **Constitutive or constraint relevance:** the entity or state would not retain the declared identity, structure, or admissible state-space without the relation.
- **Persistence or enabling relevance:** the relation materially changes survival, duration, stability, or capacity to function.
- **Decision relevance:** incorporating the relation changes a preregistered action, ranking, control, or expected loss under a declared decision problem.

No one criterion is universal. Predictive contribution is not identical to causal importance, and a redundant causal relation may add little predictive gain. Materiality must therefore be defined within a relation family and domain, with raw effects and uncertainty reported. Cross-domain results may be compared only after justified standardization; they must not be treated as naturally commensurable.

### 3.5 Relation strata

Relation classes are reported in three registers:

- **P — present-horizon relations:** current causal influence, exchange, feedback, dependency, exposure, or consequence pathways within the declared horizon.
- **K — constitutive and constraint relations:** relations that define admissible states, composition, persistence, or system identity at the time of inquiry.
- **H — historical relations:** formation, origin, inheritance, or causal history.

Historical relations are scientifically important but often easy to satisfy in broad physical and biological domains. They are therefore reported separately and never used to rescue a failed P or K hypothesis. The claim that common cosmological history *guarantees* a formation relation for every physical entity is rejected; the appropriate statement is that broad historical relations may be highly prevalent and weakly discriminating in some domains.

### 3.6 Separation

Spatial, boundary, operational, statistical, and signaling separation are real and routinely observed. Absolute relational isolation is stronger: no qualifying relation of any preregistered class above declared sensitivity within the domain and horizon. A bounded study can support or reject only a **relation-family-specific operational separation** claim. An adequate negative for information

exchange, for example, is not evidence of absence of constitutive, historical, thermal, gravitational, or other relations. The words “separate” and “isolated” must therefore be indexed to the relation family, threshold, boundary, horizon, protocol, and search budget. No bounded study can search every logically imaginable relation across all scales and all time.

## 4. Seven rows that must not be merged

Seven-row claim architecture. A concerns empirical appraisal; B and B-U concern bounded detection and relational hypotheses; D–F remain separate logical, abductive, and ontological claims.

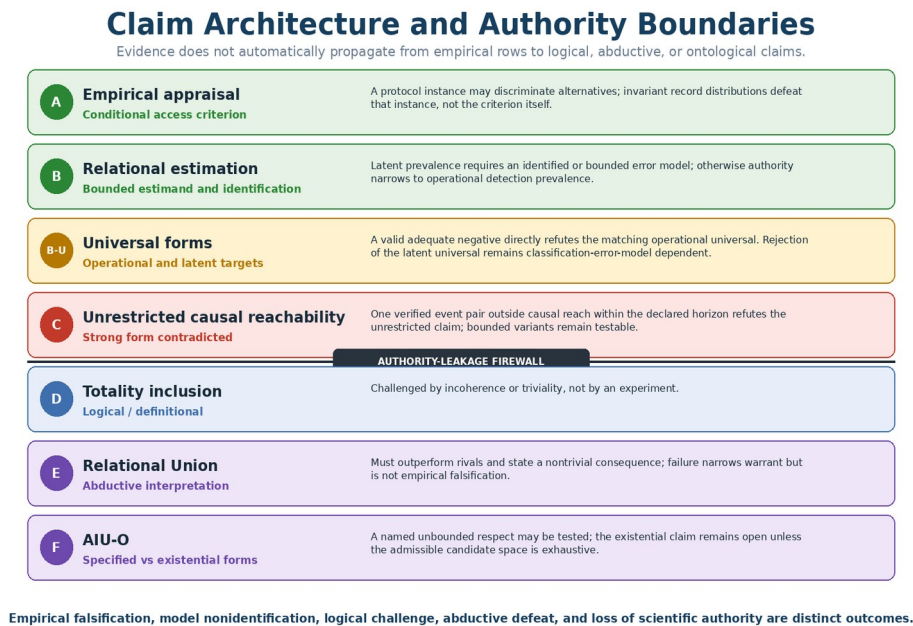


*Figure 1. Claim architecture and authority boundaries. Empirical evidence does not automatically propagate upward. Scientific falsification, model nonidentification, logical incoherence, abductive defeat, and loss of empirical authority are distinct outcomes.*

### 4.1 Compact claim register

- **A — Empirical appraisal.** A protocol can make alternatives discriminable; a realized record can provide directional evidence and incremental confirmation; decision-grade confirmation additionally requires a declared rule. **Warrant:** near-analytic and model-relative. **Status:** strong as an access condition, not an ontological result.
- **B — Relational estimation.** Operational detection prevalence and, where identified or bounded, latent relation prevalence can be estimated in declared domains. **Warrant:** empirical and bounded. **Status:** systematic estimates pending.
- **B-U — Universal forms.** Universal and near-universal claims must be stated separately for finite frames, counterexample exposure, and open populations, and must declare whether the target is operational classification or latent relation status. **Warrant:** high-risk empirical hypotheses. **Status:** operational forms are directly counterexample-exposed; latent forms remain classification-error-model dependent.
- **C — Unrestricted present-horizon pairwise causal reachability.** For every ordered pair of verified target events, a permitted intervention at the first can affect the second within

the declared horizon. **Warrant:** universal empirical claim. **Status:** the unrestricted form is contradicted by spacelike and horizon-blocked event pairs; bounded domain-and-horizon variants remain testable.

- **D — Totality inclusion.** Everything actual belongs to actuality. **Warrant:** logical or definitional. **Status:** strong but experimentally thin.
- **E — Relational Union.** Total reality is best understood as one integrated relational structure. **Warrant:** abductive philosophy. **Status:** open and rival-dependent.
- **F — AIU-O.** The existential form  $F_{\exists}$  states that total reality is unbounded in at least one concrete respect. A specified subclaim  $F_r$  names a particular respect  $r$ . **Warrant:** ontological hypothesis. **Status:** a specified  $F_r$  may be testable;  $F_{\exists}$  remains open and is not entailed by mathematics or B.

The architecture has seven rows because B-U remains separate from estimation under B. Within B-U, finite-frame, counterexample, and superpopulation formulations have different support and falsification conditions.

## 4.2 Falsification, narrowing, and deauthorization

The rows do not all fail in the same way. **B-U and C contain directly counterexample-exposed empirical universals.** A is a conditional criterion of discriminability; B distinguishes estimands from what a design can identify; D is definitional; E is abductive; and F contains both specified and existential ontological forms. Calling every adverse result “falsification” would reproduce the authority leakage this architecture is designed to prevent.

**Table 1. Empirical rows**

| Row      | Authority type                                 | What raises warrant                                                                                                                           | What defeats, narrows, or deauthorizes the claim                                                                                                    | Present status                |
|----------|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| <b>A</b> | Conditional, model-relative access criterion   | A specified hypothesis pair and observation protocol induce different record distributions, and a realized record bears directionally on them | Identical record distributions show <b>no discriminability for that specified instance</b> . This does not falsify the conditional criterion itself | Strong as an access condition |
| <b>B</b> | Empirical estimand plus identification problem | Reproducible operational estimates; latent-prevalence estimates only when detection error is identified or bounded                            | Nonidentification or failed calibration removes authority for latent prevalence and narrows the result to operational detection prevalence          | Estimates pending             |

| Row   | Authority type                                 | What raises warrant                                                                                                                                                                                     | What defeats, narrows, or deauthorizes the claim                                                                                                                                                                                                             | Present status                                                                 |
|-------|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| B-U-F | Finite-frame operational and latent universals | Operational: every member is classified positive under the frozen protocol. Latent: every member truly possesses the relation, under an identified or bounded error model.                              | Operational: one valid adequate negative. Latent: decision-grade rejection only under the preregistered and validated or bounded classification-error model.                                                                                                 | Operational form directly falsifiable; latent form error-model dependent       |
| B-U-C | Counterexample-exposed operational universal   | Survival of preregistered adversarial searches with increasing coverage, sensitivity, and valid classification controls                                                                                 | One independently verified valid adequate-negative classification in the declared domain                                                                                                                                                                     | Operational form directly falsifiable; latent inference bounded by error model |
| B-U-S | Open-population exact or near-universal target | Declare operational or latent target. Exact universality is not confirmed by a finite sample; near-universality gains decision-grade support only when a preregistered lower bound meets the threshold. | Operational exact target: one valid negative. Latent target: rejection follows only under the declared error model; a near-universal target is refuted by a valid upper bound below threshold or an exhaustive frame exceeding the permitted negative count. | Exact universality not finitely confirmable; near-universality testable        |

| Row | Authority type                | What raises warrant                                                                                               | What defeats, narrows, or deauthorizes the claim                                                       | Present status                                                      |
|-----|-------------------------------|-------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| C   | Unrestricted causal universal | A bounded variant gains support when causal reachability is demonstrated for its declared event pairs and horizon | One verified event pair outside causal reach within the declared horizon refutes the unrestricted form | Strong unrestricted form contradicted; bounded variants remain open |

Table 2. Logical, abductive, and ontological rows

| Row | Authority type            | What raises warrant                                                                                                             | What defeats, narrows, or deauthorizes the claim                                                                                                                                                                           | Present status                                                 |
|-----|---------------------------|---------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|
| D   | Logical / definitional    | Coherent and useful definition of actuality                                                                                     | Incoherence, equivocation, or complete explanatory triviality                                                                                                                                                              | Strong but experimentally thin                                 |
| E   | Abductive ontology        | It outperforms live rivals on nontriviality, scope, parsimony, unification, discriminating consequences, and unresolved residue | It loses that comparison or fails to state any consequence beyond co-membership                                                                                                                                            | Live candidate among rivals; not empirically confirmed         |
| F   | Ontological unboundedness | A specified $F_r$ gains support when an unbounded respect is operationally defined and independently corroborated               | A valid finite bound in the <b>same exhaustive respect</b> refutes that specified $F_r$ . Bounding one respect does not refute $F_3$ ; permanent untestability removes scientific authority but does not establish falsity | Specified forms may be testable; existential form remains open |

The logical burden for refuting a universal is one counterexample, but the evidential burden for certifying an adequate negative may be high. Controls, exclusion precision, frozen definitions, independent adjudication, and replication are what turn a putative counterexample into an authority-bearing result. No empirical result may be cited as though it confirmed D, E, or the existential form of F, and no failure to refute them may be counted as confirmation.

## 5. The Empirical Appraisal Condition

### 5.1 Statement

Empirical appraisal requires a declared observation model under which admissible records can bear differently on relevant alternatives. A realized record may provide directional evidence and incremental confirmation. Decision-grade confirmation additionally requires a declared evidential or decision rule.

## 5.2 What it establishes

The condition establishes that empirical claim authority depends upon discriminating evidence. A completely evidentially inert posit cannot be empirically confirmed. This disciplines claims about hidden agents, inaccessible objects, and alleged effects: if the permitted observations are invariant across the relevant alternatives, the inquiry has not empirically distinguished them.

## 5.3 What it does not establish

It does not establish:

- that a particular realized record supports the target rather than an alternative;
- that weak incremental support crosses an adequate decision-grade threshold;
- a material relation independent of measurement;
- directed causation from target to record;
- universal pairwise connection;
- one substance or one consciousness;
- physical infinity;
- Union-Based Ethics.

Its scientific strength comes from keeping identifiability, directional evidence, incremental confirmation, decision-grade confirmation, and ontology separate.

# 6. Operational Relational Constitution

## 6.1 Latent state and observed detection

For entity  $i$  and relation family  $r$ , let  $Y_{ir}=1$  mean that the entity possesses at least one qualifying relation under the frozen ontology, boundary, horizon, and materiality threshold. Let  $X_{irk}=1$  mean that detection method  $k$  reports such a relation. The observation process may have imperfect sensitivity and false-positive probability:

$$p_{irk}=P(X_{irk}=1 \mid Y_{ir}=1), \alpha_{irk}=P(X_{irk}=1 \mid Y_{ir}=0).$$

Nondetection is not automatically absence, and a detected relation is not automatically a true positive. Standard occupancy models distinguish latent occurrence from imperfect detection, while generalized models additionally permit false-positive observations [22, 28]. Replicated or complementary detection methods, positive and negative controls, validation subsets, and sensitivity analyses should be used where feasible.

## 6.2 Two different prevalence targets

The **latent relation prevalence** is:

$$\theta_r=P(Y_{ir}=1 \mid i \in B).$$

Estimating  $\theta_r$  requires a defensible observation model linking detection to latent status, including false-positive and false-negative processes that are identified or bounded.

The **operational detection prevalence** under frozen protocol  $Q$  is:

$$\phi_r^Q = P(X_{ir}^Q = 1 \mid i \in B).$$

When sensitivity and specificity cannot be estimated or credibly bounded, the study must report  $\phi_r^Q$  rather than present it as an unbiased estimate of  $\theta_r$ .

### 6.3 Three-state operational classification

Under protocol  $Q$ , classify each entity-relation-family assessment as:

- $Z_{ir}=1$ : a qualifying relation is operationally confirmed above the preregistered threshold;
- $Z_{ir}=0$ : an adequate operational negative is established;
- $Z_{ir}=U$ : the result remains unresolved because evidence, precision, search power, identity, or adjudication is inadequate.

A classification is an output of the frozen protocol. It is not automatically identical to latent relation status.

### 6.4 Adequate operational negatives

Statistical nonsignificance alone is insufficient. For a relation defined by an effect magnitude  $\tau_r$ , an adequate negative should normally exclude effects at or above that threshold with declared precision. For example, for a one-sided effect parameter  $\beta_{ir}$ :

$$U_{1-\alpha}(\beta_{ir}) < \tau_r,$$

or, under a declared Bayesian model:

$$P(\beta_{ir} \geq \tau_r \mid \text{data}) < \gamma.$$

The frozen protocol must complete successfully, controls must behave within preregistered bounds, the relation-family analysis must exclude material effects with the required precision, and no qualifying relation may be established.

### 6.5 Finite-frame classification identification interval

For a completely enumerated finite frame of size  $N$ , let  $n_1$  be operational positives,  $n_0$  adequate operational negatives, and  $n_U$  unresolved cases, with  $N = n_1 + n_0 + n_U$ . Before model-based imputation, report:

$$\phi_L^Q = \frac{n_1}{N}, \phi_U^Q = \frac{n_1 + n_U}{N}.$$

This is a **finite-frame classification identification interval**, not a confidence interval and not a correction for misclassification. It assumes only that confirmed positives and adequate negatives are classified as stated and that unresolved cases could lie on either side. Partial-identification logic requires stronger conclusions to be tied to stronger assumptions [23].

Studies must report separately:

- **classification uncertainty**: the 1/0/U interval;

- **measurement uncertainty:** sensitivity to false-positive and false-negative rates;
- **sampling uncertainty:** confidence or credible intervals when sampling occurs;
- **design uncertainty:** sensitivity to individuation, taxonomy, horizon, threshold, and search budget;
- **model uncertainty:** sensitivity to plausible detection and adjudication models.

Unknown is neither zero nor one.

## 6.6 Universality and near-universality

B-U must be split into three forms.

**Operational and latent targets.** Each universal claim must declare whether it concerns protocol output  $Z_{ir}(Q)$  or latent status  $Y_{ir}$ . An operational universal is defined over frozen classifications and is directly refuted by a valid  $Z_{ir}(Q)=0$ . A latent universal is defined over underlying relation status; an adequate operational negative is decision-grade evidence against it only to the extent warranted by the preregistered, validated, or bounded classification-error model. Unless zero classification error is justified,  $Z_{ir}(Q)=0$  does not deductively entail  $Y_{ir}=0$ .

### B-U-F — finite enumerated frame

B-U-F has two forms. Operational B-U-F<sup>Z</sup> states that every member of a completely enumerated finite frame is classified positive under the frozen protocol, with no unresolved or invalid classifications. One valid adequate operational negative directly refutes B-U-F<sup>Z</sup>. Latent B-U-F<sup>Y</sup> states that every member truly possesses the qualifying relation. An adequate operational negative may justify decision-grade rejection of B-U-F<sup>Y</sup> under the declared error model, but it does not deductively falsify the latent universal unless zero classification error is warranted. All-positive classification supports only the declared operational frame and remains subject to measurement error when interpreted latently.

### B-U-C — counterexample claim

Operational B-U-C<sup>Z</sup> states that no independently verified entity in the declared domain receives a valid adequate-negative classification for relation family  $r$ . One valid  $Z_{ir}(Q)=0$  refutes it. The corresponding latent counterexample claim remains classification-error-model dependent and cannot be universally confirmed from an ordinary sample.

### B-U-S — open-population universality

Open-population studies must declare whether  $\theta_r$  denotes operational classification prevalence or latent relation prevalence. The latter requires an identified or credibly bounded observation and misclassification model.

$$\theta_r = 1$$

for an open or continuing population. A finite all-positive sample does not establish equality to one. Under independent Bernoulli sampling with a fixed population parameter, the exact one-sided Clopper–Pearson  $1 - \alpha$  lower confidence bound after  $n$  successes in  $n$  trials is [27]:

$$L_{1-\alpha} = \alpha^{1/n}.$$

It remains below one. For  $n=100$  and  $\alpha=0.05$ ,  $L_{0.95}=0.9705$  after rounding to four decimal places. This bound does not apply unchanged to dependent, adaptively selected, or outcome-ascertained cases.

The normal inferential target should therefore be a preregistered near-universality claim:

$$B_{\varepsilon,r}:\theta_r \geq 1 - \varepsilon,$$

with  $\varepsilon$  justified before data access.

## 6.7 Verified-frame ascertainment boundary

The empirical frame is conditional on independently verified entities:

$$\theta_r = P(Y_{ir}=1 \mid V_i=1, i \in B).$$

Verification may itself depend on detectability, persistence, documentation, or prior interaction. Therefore results for verified entities do not automatically generalize to inaccessible, disputed, unregistered, or undetected entities. The sampling frame must be constructed independently of the particular relation outcome under test, every pathway into the frame must be documented, and differential inclusion should be modeled or bounded where possible [24].

## 6.8 Taxonomy, protocol, and search-budget indexing

Relational prevalence is indexed by the complete search design:

$$\theta_r = \theta_r(B, T, R^i, \tau_r, Q, S),$$

where  $B$  is the frame,  $T$  the horizon,  $R^i$  the frozen taxonomy,  $\tau_r$  the materiality threshold,  $Q$  the detection and adjudication protocol, and  $S$  the search budget or stopping design. Estimates from different studies are not directly comparable unless these elements are harmonized or explicitly standardized.

## 6.9 Revised synthetic example

Suppose a finite frame contains 12 engineered modules. Under a frozen present-horizon protocol, 7 are operational positives, 3 are adequate negatives, and 2 remain unresolved. Then:

$$0.583 = \frac{7}{12} \leq \phi_p^Q \leq \frac{9}{12} = 0.750.$$

This interval describes operational classifications. If validation work suggests sensitivity between 0.85 and 0.95 and false-positive probability between 0.01 and 0.05, the latent prevalence  $\theta_p$  requires an additional measurement-error analysis and will generally have different bounds. The example does not supply those bounds because the joint error model and validation data have not been specified.

Operational B-U-F<sup>^</sup>Z fails for this frame because three adequate negatives are observed. The evidence against latent B-U-F<sup>^</sup>Y depends additionally on the validated or bounded misclassification process. Constitutive and historical strata may produce different estimates and must remain separate.

## 6.10 Controlled null example

Consider a shielded computational module tested for present-horizon information exchange above a declared bandwidth and time horizon. Positive controls detect injected traffic, negative controls remain quiet, the observation process is sufficiently precise to exclude exchange at or above  $\tau_r$ , and the stopping rule is reached. The result is an adequate operational negative for this relation family and horizon. It lowers operational detection prevalence, refutes the matching operational finite-frame universal, and provides decision-grade evidence against the corresponding latent universal only under the declared error model. It does not prove that the module has no constituents, no history, no shared physical constraints, or no relation at every scale.

## 6.11 Construct validity

The central measurement risk is that “relation” is defined so broadly that support is guaranteed. Construct validation therefore requires [4–5]:

- **content validity:** the taxonomy covers the intended family without importing trivial co-membership;
- **discriminant validity:** the instrument separates material relation from naming, measurement coupling, generic shared law, and analyst imagination;
- **convergent validity:** independent methods agree where they target the same relation;
- **criterion validity:** classifications predict intervention, persistence, or decision consequences where such criteria exist;
- **consequential validity:** the instrument does not reward unlimited relation listing or conceal uncertainty.

Every study should use positive controls, credible negative controls, blinded classification where feasible, reliability assessment, error-model sensitivity, and stopping rules.

## 6.12 What counts against the program

A bounded counterexample requires independent verification, a frozen entity and relation definition, declared instruments and search budget, an adequate-negative exclusion criterion, successful controls, independent adjudication, and replication where feasible. Such a result can directly refute the matching operational B-U-F<sup>^</sup>Z or B-U-C<sup>^</sup>Z claim, provide error-model-governed evidence against the corresponding latent claim, lower estimated prevalence, or show that a detection method is inadequate. No null may be rescued through unlimited post-hoc expansion of the taxonomy, horizon, or search budget.

Protocols must also preregister a domain- and purpose-justified maximum tolerable unresolved-case rate, escalation and adjudication rules, search-budget equality across comparison conditions, and the consequences of excessive unresolved classifications. Exceeding that ceiling is not evidence for or against the substantive relation hypothesis; it prevents the preregistered decision-grade conclusion and requires redesign or narrower reporting.

## 6.13 Narrowing is a legitimate result

The program may find high prevalence in living systems, lower prevalence in deliberately decoupled systems, large differences between present, constitutive, and historical strata, or strong

dependence on detection protocol and search effort. These are scientific outcomes, not defects to be hidden.

#### 6.14 Worked isolation challenge: certifying a protocol-indexed adequate negative

The purpose of an isolation challenge is not to prove that an entity is absolutely separate. It is to test whether a **specified relation family** is absent above a materiality threshold within a frozen boundary, horizon, interface set, and search protocol. This subsection gives one illustrative design; its constants are declared, not measured.

**Setup.** Candidate entity: a shielded computational module. Frozen relation family  $P_Q$ : unauthorized digital information transfer between the module and its local environment through a declared physical-interface set  $Q$  during horizon  $T$ . Materiality threshold:  $\tau_p = 1$  bit/s. Estimand  $\beta_Q$ : the achieved causal protocol-indexed transfer rate from randomized module-side challenge inputs to decoded environment-side outputs over  $Q$  under a prespecified intervention, decoder, interface set, error-rate criterion, and stopping rule. Associations generated only by common inputs or shared timing do not qualify as transfer from the module. It is **not** unconstrained Shannon channel capacity, which would require a declared channel model and optimization over admissible input distributions [1].

The design injects independently randomized challenge sequences at every monitored interface, estimates directional transfer from intervention to decoded response under a frozen decoder and error model, and constructs simultaneous one-sided 95% upper confidence bounds across  $Q$ . The design must preregister per-interface prospective power at  $\tau_p$  and the family-level probability that the complete required positive-control set passes. If every positive control must pass, the design should achieve at least 0.95 prospective probability of satisfying that joint control gate under the declared control configuration, or use a justified sequential or redundancy-aware acceptance rule. Classification  $Z=0$  requires all of the following:

1. the preregistered family-level positive-control gate passes;
2. sham controls remain within the familywise false-alarm bound;
3. the simultaneous upper bound satisfies  $U_{0.95}^{sim}(\beta_Q) < \tau_p$ ;
4. monitoring integrity, stopping rules, and interface coverage all pass; and
5. no qualifying transfer is established by any complementary method.

**Table 3. Illustrative controls and result**

| Arm                      | Frozen condition                                                                | Requirement                                                                                                                                                                                    | Illustrative result                                             |
|--------------------------|---------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| <b>Positive controls</b> | One randomized 1 bit/s covert channel injected through each monitored interface | Per-interface prospective power $\geq 0.95$ at $\tau_p$ ; family-level probability that the complete required control set passes $\geq 0.95$ , or a justified sequential/redundancy-aware rule | Joint positive-control gate passes under the preregistered rule |
| <b>Negative controls</b> | Sham sequences with no encoded channel                                          | Familywise false-alarm probability $\leq 0.05$                                                                                                                                                 | No sham channel classified positive                             |

| Arm         | Frozen condition                                              | Requirement                         | Illustrative result                                                                                     |
|-------------|---------------------------------------------------------------|-------------------------------------|---------------------------------------------------------------------------------------------------------|
| Test module | Unknown transfer status across the declared interface set $Q$ | $U_{0.95}^{sim}(\beta_Q) < 1$ bit/s | $\hat{\beta}_Q = 0.05$ bit/s and $U_{0.95}^{sim} = 0.20$ bit/s: adequate operational negative for $P_Q$ |

**Reading the result.** The module is classified  $Z=0$  only for relation family  $P_Q$ , threshold  $\tau_P$ , interface set  $Q$ , and horizon  $T$ . If any interface is unmonitored, the family-level positive-control gate fails, multiplicity is not controlled, or the upper bound does not exclude  $\tau_P$ , the correct code is  $Z=U$ , never  $Z=0$ . A passed positive-control gate demonstrates sensitivity to the declared challenge; it does not prove sensitivity to every unknown physical channel.

**What this negative does and does not do.** It refutes operational B-U-F<sup>^</sup>Z for relation family  $r$  in any finite frame containing the module and lowers operational detection prevalence. It supports rejection of latent B-U-F<sup>^</sup>Y only to the extent warranted by the declared and validated error model. It does not establish absence of constitutive, historical, thermal, electromagnetic, gravitational, mechanical, or other relations, and it does not prove absolute isolation. One valid operational counterexample is logically sufficient to refute the matching operational universal, but the claim boundary must remain exactly as narrow as the test.

## 7. Evidence and constraints across domains

This section is illustrative rather than systematic. It motivates candidate domains and relation classes; it does not estimate universal prevalence.

### 7.1 Measurement and causal inference

Records and causal models are relational by construction [1–3]. However, statistical dependence, predictive usefulness, and causal effect are not interchangeable. A variable can be predictively useful without being causal, and a causal relation can be predictively redundant when proxies are present [6]. This is why the materiality framework uses multiple relation-specific criteria.

### 7.2 Quantum theory

Loophole-free Bell tests reject broad local hidden-variable explanations under their tested assumptions [7–9]. They establish nonclassical correlations, not controllable faster-than-light signaling, universal consciousness, or a relation between every pair of physical systems. Quantum results constrain simplistic separability; they do not directly measure B across arbitrary entities.

### 7.3 Relativity and horizons

Relativity distinguishes common causal history, present signaling reachability, and future causal contact [10–11]. Spacelike separation and cosmological horizons limit operational communication. They do not prove metaphysical fragmentation, but they block the inference from shared history to present pairwise causal connectivity.

## 7.4 Cosmology

The standard cosmological model supports a hot, dense early history for the observable universe [12]. That statement is bounded to the observable domain and current model. It does not prove physical infinity, one substance, a universal common origin for all possible reality, or identical laws in inaccessible domains.

## 7.5 Biology and ecology

Common ancestry is strongly supported for terrestrial life [13]. Organisms, microbiomes, food webs, and biogeochemical cycles provide clear cases of dependency, exchange, constitution, and enabling conditions. Their obvious relationality is valuable, but it cannot by itself establish a universal claim about every physical entity.

## 7.6 Networked civilization

Infrastructure, finance, public health, supply chains, communications, and governance form coupled networks. Interdependent systems can propagate cascades that isolated-component models miss [14]. Coupling may produce resilience or fragility. The warranted lesson is to model material relations and preserve appropriate boundaries, buffers, redundancy, and containment.

## 7.7 Holography and emergent geometry

Holographic ideas and ER=EPR motivate inquiry into links among information, entanglement, and geometry [15–18]. Their clearest realizations concern special theoretical settings. They are frontier motivations for relational ontology, not evidence that our whole cosmos is one operationally connected object.

# 8. Falsifiability and underdetermination

A null result can reflect the target hypothesis, instrumentation, auxiliary assumptions, scale, or taxonomy. Freezing criteria, preregistering analyses, using controls, and independent adjudication constrain but do not eliminate underdetermination [19–21]. Results must therefore be stated as:

No qualifying relation of class  $r$  was detected above sensitivity  $S$  within boundary  $B$  and horizon  $T$ .

They must not be inflated into “no relation exists anywhere.” Positive results require equal caution: detection of an arbitrarily faint or analytically constructed association does not establish a material relation.

# 9. Staged research program

## Study 1 — Bounded relational prevalence census

Construct a frame independently of the relation outcome under test and document all inclusion pathways. Freeze entity individuation, ascertainment rules, relation taxonomy, thresholds, observation protocol, and search budget. Report operational detection prevalence first. Estimate latent prevalence only where false-positive and false-negative processes are identified or bounded.

Separate finite-frame classification intervals, measurement-error bounds, sampling uncertainty, and design sensitivity. Treat cases and entities as sampled materials when generalizing beyond the exact frame [22–25].

## Study 2 — Isolation-Challenge benchmark

Preselect strong candidates for operational independence, including isolated laboratory systems, high-vacuum systems, decoupled computational modules, and remote natural objects. Use positive and negative controls, repeated or complementary detection methods, explicit exclusion thresholds, and relation-class-specific stopping rules. The study is designed to produce adequate operational negatives and real counterexamples rather than nonsignificant results. §6.14 gives a worked certification of one such adequate negative.

## Study 3 — Relational versus independence-based prediction

Compare relation-aware and complexity-matched independence models on preregistered out-of-sample outcomes. Include strong-, weak-, and uncertain-coupling domains. Measure prediction, calibration, false alarms, interpretability, and decision value. Use model-class reliance or an equivalent robustness analysis so importance is not defined by one selected model [6]. Generalization beyond the exact case set requires a declared case universe and case sampling or appropriately bounded transfer claims [25].

## Study 4 — Governance omission experiment

Compare unaided judgment, a credible conventional structured method, full MathGov / RippleLogic, and ablation conditions. Primary outcomes include material stakeholder recall, worst-affected-group detection, rights hazards, tail-risk pathways, enabling dependencies, unsupported claims, and unknown-to-zero errors. Countermetrics include irrelevant-item inflation, false positives, excessive escalation, time, burden, and inter-rater reliability. The full protocol is specified in the companion H\_I Omission Study Protocol.

# 10. What follows and what does not

## 10.1 What follows

- Empirical appraisal requires discriminability; a realized record may provide directional evidence and incremental confirmation, while decision-grade confirmation additionally requires a declared rule.
- Many important entities and systems have independently measurable causal, constitutive, historical, dependency, exchange, or consequence relations.
- Real boundaries and approximate independence can coexist with wider relational structures.
- Operational detection prevalence can be estimated within bounded domains; latent prevalence requires an identified or bounded observation model.
- Relational models should be compared against simpler alternatives rather than assumed superior.

## 10.2 What does not follow

- Unrestricted present-horizon causal reachability holds across every ordered event pair.
- Every verified entity has a material present-horizon relation.
- All entities are identical or sentient.
- Individuality is unreal.
- Quantum mechanics proves universal consciousness.
- Physical space is infinite or a multiverse exists.
- Relational union or AIU-O is proved.
- Union-Based Ethics is logically forced by physics.
- MathGov improves outcomes.

## 11. Conclusion

The scientifically secure base is narrower and more useful than the slogan “everything is one.” Empirical appraisal is relational at the level of records, alternatives, and observation models. Beyond that, the substantive question is distributional and domain-indexed: which verified entities possess which qualifying relations, at what magnitude, under what horizon and sensitivity?

This formulation gives reality a genuine opportunity to answer no. It can reveal high relational prevalence, mixed domains, relation-family-specific operational negatives, or failed relation-aware models. It preserves the insight that boundaries occur within wider histories and structures without converting that insight into a universal conclusion before measurement.

The paper supplies an empirical methods base. The companion paper states the additional philosophical and normative premises required to move toward relational union, Union-Based Ethics, and a direction for intelligence.

## Appendix A. Minimum preregistration fields

- Target domain, target population, and sampling or census frame.
- Entity individuation rule: how units are distinguished, merged, split, persisted through time, or excluded.
- Ascertainment pathways into the verified-entity frame.
- Entity identity and independent verification or appraisal standard.
- Frozen relation families, strata, and exclusions.
- Relation-specific materiality criteria and minimum detectable or excludable effects.
- Latent-state definition and operational detection rule.
- False-positive, false-negative, and unresolved-case treatment, including a preregistered maximum unresolved-case rate, escalation and adjudication rules, and consequences for exceeding the ceiling.
- Model classes, intervention assumptions, constitutive tests, or historical evidence rules.
- Instruments, scales, protocol  $Q$ , search budget  $S$ , and time horizon  $T$ .
- Positive and negative controls.
- Three-state operational coding for positive, adequate negative, and unresolved cases.

- Classification identification interval and measurement-error sensitivity.
- Sampling uncertainty and design-sensitivity analysis.
- Independent adjudication and inter-rater plan.
- Stopping rule prohibiting post-hoc expansion.
- Outcomes for support, narrowing, and rejection.
- Publication plan for null, negative, and adverse findings.

## Appendix B. Compact public statement

Empirical appraisal requires a declared observation model under which records can bear differently on alternatives. A realized record may provide directional evidence and incremental confirmation; decision-grade confirmation additionally requires an explicit evidential or decision rule. Beyond that near-analytic point, material relationality is an empirical question. Studies must distinguish latent relation status from imperfect detection, report operational detection prevalence when error processes are not identified, preserve unresolved cases, and index results to the sampling frame, taxonomy, threshold, horizon, protocol, and search budget. Exact universality can be refuted by a validated counterexample but cannot be established for an open population by a finite all-positive sample. Distinction and boundaries are real. The unrestricted form of universal present-horizon causal reachability is contradicted by causal structure, while bounded causal-reachability and relational-prevalence claims remain domain-, horizon-, and protocol-specific.

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