

Preserving Uncertainty across Successive Summaries of Testimony in Institutional Investigations

Wanhong HUANG
huangwanhong@serendip.ngo

Abstract

Institutional investigations often rely on records that have passed through several authors and summaries. A later document can faithfully transmit a mistaken belief, silently strengthen a qualified account, or multiply the apparent evidential weight of one source. This paper develops a typed framework for preserving uncertainty across those transformations. It separates the event, a witness’s interpretation, the witness’s recorded account, a summarizer’s inference, and an authorized finding. A semantic weakening condition characterizes transformations that introduce no new asserted consequences within a fixed interpretation domain. A distinct factorization condition determines exact recovery of declared source targets. Constructed counterexamples show that conservative weakening can still lose qualifications needed for a later inquiry, and that accurate source-target extraction can transmit a false allegation. A probabilistic source-dependence model compares repeated copies with independent reports and derives bounds when their generating structure remains uncertain. An optimal-risk comparison clarifies why information loss can coexist with improved performance by actual readers. A worked institutional packet retains target time, attribution, qualifications, source access and revision history. Primary provenance, archival, source-monitoring and investigation materials establish antecedents and practical constraints. A proposed evaluation separates record fidelity, attribution accuracy, uncertainty recovery and justified belief. The formal results are conditional; institutional effectiveness and the prevalence of the diagnosed failures remain empirical questions.

Keywords: testimony; institutional investigations; record provenance; evidential uncertainty; source dependence; summarization

Research Note

This paper develops a bounded argument through conceptual distinctions, stated assumptions, conditional derivations, worked examples, and objections. Its length follows the requirements of that argument. Formal statements concern the specified models; the application of those models to persons and institutions requires independent interpretation and evidence. Constructed examples are explicitly identified and carry illustrative status.

The manuscript follows the repository’s paper template for typography, numbered formal statements, section structure, citations, and navigable contents. The associated project files preserve research provenance, source verification, derivation records, unresolved objections, and validation results. Philosophical commitments about the ultimate nature of social facts remain suspended where the descriptive framework is sufficient for the argument.

Authorship and Research Assistance

Wanhong Huang directed the research questions and authorized this paper’s preparation. An AI research assistant helped organize the material, develop explicit formal constructions, check primary sources, and prepare the text. Agent-added arguments and formulations remain subject to the author’s review. Source positions, repository proposals, and model consequences are distinguished throughout the manuscript.

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1 Introduction

This paper examines the preservation of uncertainty when testimony passes through successive summaries in an institutional investigation. It distinguishes what happened, what a witness understood, what the witness recorded, what a later author inferred, and what an authorized procedure eventually found. The analysis combines typed records, conditional semantic and statistical results, a fictional evidence packet and a prospective evaluation design. Internal workplace inquiry supplies the main practical illustration.

Consider a witness who says that a colleague appeared distressed but that the cause was unclear. An interview note records the qualification. An internal summary states that the colleague was distressed by an interaction. A later report cites the summary, and a briefing cites the report. The final document may appear well supported because several documents repeat the statement. Yet the sequence can have changed both the content of the allegation and the apparent independence of its support.

Several questions arise within that simple example. The witness may have been mistaken about distress. The interview note may have faithfully recorded that mistaken interpretation. The summary may have dropped an uncertainty qualifier or added a causal attribution. The later briefing may have accurately quoted the summary while giving it a stronger evidential role. These possibilities require distinct descriptions of error. A general statement that information is lost at each stage would leave the most consequential changes unspecified.

The source discussion motivates two linked insights. First, an observer's account is itself an authored manifestation with conditions of production. A record about another person's experience is evidence of an interpretation whose relation to that experience needs investigation. Second, preservation has a prospective role: later readers need sufficient access to origins, qualifications and transformations to reassess a conclusion. The present paper develops the first insight into a scoped account of summary fidelity, while locating the second within explicit access and governance limits.

The main contribution is a separation of three preservation tasks. Conservative semantic transformation prevents a summary from asserting consequences that exceed its declared inputs. Target preservation keeps particular source distinctions recoverable, such as who expressed a view, how certain it was, and which earlier record supplied it. Dependence preservation records whether several apparent reports share one evidential origin. These tasks can vary independently. A cautiously worded summary can erase a qualification needed for later review; a detailed source map can accompany an inaccurate statement; an exact quotation can transmit a false belief.

The mathematics is elementary where elementary mathematics suffices. A set-inclusion argument gives compositional semantic restraint. A factorization argument gives exact recovery of a declared target. A finite probabilistic example derives the difference between copied and independently generated reports. The contribution lies in the typed application, the separation of obligations and the resulting investigation design. Novelty priority for the broader literature remains an open assessment.

The analysis also preserves an important countercondition. A later interpreter can correct an earlier error by using the same source more carefully. A new witness can introduce information. A changed question can make a previously adequate summary insufficient. These possibilities rule out a universal law of increasing error with each institutional step. They support a more precise inquiry into which information is available, which interpretation is being attempted, and which transformation produced the current record.

The paper proceeds from antecedents and record types to semantic preservation, target recovery and dependence. It then develops a complete fictional packet, correction rules and institutional objections. Its proposed evaluation distinguishes fidelity to a record from correctness about the world. That distinction is essential when the subject matter includes another person's experience: faithful preservation gives later inquiry a better starting point, while the warrant for the underlying attribution remains separately answerable.

2 Provenance, Source Monitoring and Investigation Practice

This section situates the proposed framework in verified primary sources. The comparison identifies existing attention to origins, interpretation and record integrity. It then specifies the narrower contribution that remains available for the present argument.

The W3C PROV data model supplies a vocabulary for entities, activities, agents and derivation relations. It distinguishes the use of an input from a warranted claim that an output was derived from that input [4]. This distinction is directly relevant to institutional records: a document appearing in a case folder need not have supplied the conclusion in a particular report. The actual transformation and its inputs require documentation.

PROV's representation of responsibility concerns roles in the production of entities and activities [4]. It leaves room for domain-specific interpretation. The present paper therefore distinguishes a source-attribution relation from a determination of culpability. Naming the author of a summary can help identify who made a transformation. Assigning legal or ethical responsibility for its consequences requires additional facts and standards.

Johnson, Hashtroudi and Lindsay's source-monitoring framework examines processes through which people attribute memories, knowledge and beliefs to origins. Their account treats source attribution as an evaluative process subject to error [3]. This is a precedent for taking the interpretation of origins seriously. The proposed institutional packet concerns externally retained records and their use; its performance cannot be inferred directly from a theory of individual memory.

The International Council on Archives' Code of Ethics addresses integrity, provenance, context, authenticity, intelligibility and the justification of archival actions. It also recognizes access and privacy concerns [2]. The present argument thus enters an existing field of active preservation practice. It would be inaccurate to depict archival work generally as passive storage or to claim that the importance of context begins with the present proposal.

Acas witness guidance gives a concrete procedural comparator. It recommends recording how a witness became aware of an issue, relevant event details and the time of the statement. It addresses checking and amending statements, including disagreements about whether notes accurately reflect a meeting [1]. These practices already protect distinctions that the model formalizes. Their existence makes a universal diagnosis of institutional indifference untenable.

The source comparisons establish four boundaries. Generic provenance is an antecedent. Source attribution is a studied cognitive task. Contextual preservation is an established archival concern. Witness-record checking is already part of explicit investigation guidance. The present contribution must therefore lie in a more specific account of the logical and evidential relations among summary content, attribution level, uncertainty and source dependence.

The framework addresses that remaining problem by treating a summary as a transformation with a declared input, a semantic interpretation and a purpose. A record can identify its author while concealing whether the author observed the event, heard a report or inferred a mental state. A source link can preserve a route to the original while leaving the route inaccessible to the relevant reader. A qualification can survive verbatim while a heading turns the entire passage into an apparently settled finding. These cases require the interpretation of the record package, not merely the presence of metadata fields.

The distinction also explains the relation to cumulative-history inquiry. A causal investigation asks how a sequence of events contributed to an outcome under a specified model and horizon. The present paper asks which claims, qualifications and dependencies remain available to that investigation after documentation. Better causal analysis requires adequate evidence, while a well-preserved record can still leave causal questions unresolved. Neither task can absorb the other without losing its specific evidential obligations.

Later institutional reassessment introduces further questions about retention periods, access rights and finality. The present paper provides some inputs to those questions by identifying what a record preserves. Choosing a governance arrangement requires additional normative and legal work. That boundary permits a focused paper on testimony transformations while retaining the source discussion's

wider concern for future inquiry.

3 Record Types and Attribution Targets

This section specifies the objects that a summary can preserve or confuse. It introduces the target person, observer, author, relevant times and assertion types. The definitions concern analytic roles that can occur within one document; they posit no single institutional mind behind a distributed process.

Let A be the person whose conduct or experience is discussed, B a witness or observer, and C a later interpreter. Distinguish event time τ , observation time t_o , record time t_r and review time t_c . An observation can follow the relevant event, and a record can follow both. A statement about what A experienced at τ differs from a statement about what B believed at t_o or what B wrote at t_r .

Definition 3.1 (Typed testimony record). A typed testimony record is a package

$$r = (a, z, \tau, t_o, t_r, c, \sigma, P, m, u, v, \alpha),$$

where a is the record author, z its target, c its content, σ its assertion type, P its actual input records, m its stated inferential operation, u its uncertainty qualifications, v its version information and α its access conditions.

The package is a proposed domain-specific construction. It can be implemented in ordinary prose and linked documents. A database schema is optional. The record's adequacy depends on the meaning and accuracy of its fields, including the possibility that a field is unknown or disputed. An empty parent field can mean direct production, unavailable provenance or an incomplete record; the intended meaning should be explicit.

Useful assertion types include observation of conduct, report of speech, attribution of a mental state, hypothesis about a cause, summary of an earlier account, and authorized finding under a stated procedure. The types can nest. A report may state that B inferred that A felt excluded. Removing the outer attribution changes the claim to one about A . Removing the inferential qualifier changes its evidential presentation again.

Table 1 distinguishes the targets through a single fictional interaction.

Three evaluative dimensions follow. Record fidelity concerns whether the document accurately expresses its attributed source. Interpretive warrant concerns the reasons for the source or later author to hold a belief. World accuracy concerns whether the target proposition is true. A faithful quotation can score well on the first while the quoted belief is mistaken. A poorly justified inference can accidentally reach a true conclusion. A reasonable tentative inference can become misleading when recorded as certainty.

The distinction between uncertainty and negation also matters. A witness who leaves a cause unresolved has not thereby denied that cause. A witness who says that an event failed to occur makes a different assertion. An institution that codes both cases as unsupported may be using an operational category that hides their semantic difference. Whether that compression is acceptable depends on the question the category is meant to answer.

The same caution applies to missing data. An unrecorded detail can have been unknown, omitted as irrelevant, withheld for privacy or lost through transcription. These possibilities can have different implications for later inference. The record need not list every possible omission; it should preserve known reasons when they affect the declared purpose or a foreseeable challenge.

Typed records make the Theory of Mind connection precise. An inference about what A experienced or what B believed concerns another person's mental target. An inference about the timestamp of a file need not. The common formal language of partial evidence does not erase that difference. Mental attribution requires an interpretation of expressions, history and context beyond the mechanical identity of a source document.

Table 1: Targets that can be confused within a testimony summary

Target	Illustrative content	Separate question
Conduct at τ	A left a meeting	Did the departure occur?
B’s interpretation	B took the departure to indicate distress	What did B believe and why?
B’s recorded account	B recorded a tentative interpretation	Was tentativeness retained accurately?
C’s inference	C attributed the distress to an interaction	Which inputs and inferential steps support that attribution?
Institutional finding	A panel adopted a specified conclusion	Which procedure and authority produced the finding?

4 Semantic Restraint in Successive Summaries

This section formalizes one preservation requirement: a summary should avoid introducing asserted consequences beyond its declared inputs. It defines a common interpretation domain, derives compositional restraint and exhibits a qualification failure. Exact preservation of useful source distinctions is reserved for the following section.

Let Ω be a fixed set of interpretation scenarios. A scenario specifies the aspects relevant to the argument, which can include what was said, what was inferred and what occurred. For an intelligible record r , let $K(r) \subseteq \Omega$ be the nonempty set of scenarios compatible with its asserted content under an explicit interpretation convention. This set models what the record commits its author to saying. It is distinct from the scenarios supported by all available evidence.

For a proposition φ interpreted on Ω , let $\text{Sat}(\varphi) = \{\omega \in \Omega : \varphi(\omega) \text{ holds}\}$ and write

$$r \models \varphi \iff K(r) \subseteq \text{Sat}(\varphi).$$

Entailment concerns the stated semantics. A false record can entail a false proposition because its content excludes the actual scenario. The distinction prevents a formal preservation test from being mistaken for verification of the world.

Definition 4.1 (Conservative semantic transformation). A transformation from r to s is conservative on the fixed domain and interpretation convention when

$$K(r) \subseteq K(s). \tag{1}$$

The output may weaken the source’s asserted commitments. It introduces no consequence that fails to follow from those commitments.

Proposition 4.2 (Composition of conservative transformations). *If $K(r_j) \subseteq K(r_{j+1})$ for each $j = 0, \dots, n-1$, then $K(r_0) \subseteq K(r_n)$. Consequently, every proposition entailed by r_n is entailed by r_0 .*

Proof. Transitivity of set inclusion yields the first conclusion. If $K(r_n) \subseteq \text{Sat}(\varphi)$, composing that inclusion with $K(r_0) \subseteq K(r_n)$ yields $K(r_0) \subseteq \text{Sat}(\varphi)$. $\square$

The condition applies to asserted content, including the effect of headings and attribution. Suppose r says that B tentatively interpreted A ’s departure as distress, while s says that A was distressed. A scenario in which B made the tentative interpretation and A was merely tired belongs to $K(r)$ under the stipulated semantics. It fails to belong to $K(s)$. Thus the inclusion fails. Shortening the text has strengthened one claim and discarded its attribution conditions.

An apparently cautious change can also alter meaning. Replacing a witness’s uncertainty about causation with a statement that causation is unlikely adds a direction of judgment. Replacing two rival explanations with an unspecified doubt can preserve caution while losing the alternatives. The first may fail semantic restraint; the second may satisfy restraint while failing a later target-preservation requirement.

The theorem assumes aligned semantics throughout the chain. If a later author changes the meaning of confirmed, witness or incident, a common interpretation domain needs an explicit translation. A new finding based on additional evidence may legitimately assert more. Its input should then be the combined package, with the new inferential step identified. Classifying such a finding as an ordinary summary of the old record would conceal how its stronger conclusion was reached.

Inconsistent source packages need special handling. A classical interpretation set can be empty when two assertions conflict, making every proposition follow vacuously. The present audit therefore flags an empty K for inconsistency review and retains the conflicting assertions with their authors. It does not use empty-set entailment to certify arbitrary summaries. A richer logic of attributed disagreement is possible, but its semantics would require a separate specification.

Semantic restraint is a useful minimum because it distinguishes compression from unwarranted promotion of a claim. It remains incomplete as a preservation policy. The summary “B provided an account” may be conservative while revealing almost nothing about the account. The next section identifies the additional condition needed when later readers must recover a particular qualification, target or source relation.

5 Recovery of Declared Source Targets

This section derives exact preservation for a specified source question. It distinguishes that requirement from semantic restraint and from truth about the event. The distinction permits focused preservation without demanding that every summary reproduce its entire source.

Let $\mathcal{H}$ be a domain of admissible source histories, and let $\rho : \mathcal{H} \rightarrow R$ map a history to its available summary package. A target $q : \mathcal{H} \rightarrow Y$ specifies what a later reader needs to recover. Examples include whether a witness expressed uncertainty about a cause, whether two statements derive from the same interview, or whether an account was corrected. The target’s meaning and the admitted histories must be justified before applying the result.

Proposition 5.1 (Exact target recovery). *There exists a map $\bar{q} : \rho(\mathcal{H}) \rightarrow Y$ satisfying $q = \bar{q} \circ \rho$ exactly when*

$$\rho(h) = \rho(h') \implies q(h) = q(h') \quad \text{for all } h, h' \in \mathcal{H}. \quad (2)$$

Proof. If the factorization holds, equal summaries have equal images under $\bar{q}$ and therefore equal target values. Conversely, suppose the implication holds. For an attainable record r , select any h with $\rho(h) = r$ and define $\bar{q}(r) = q(h)$. The implication makes this value independent of the selected preimage. The definition then gives the required factorization. $\square$

This elementary factorization result is inherited from the repository’s earlier query-recovery analysis. Its use here is a transfer to typed testimony targets. It identifies a precise failure witness: two source histories with the same summary and different values of the question a reader needs to answer.

Consider h_u , in which B recorded uncertainty about distress, and h_c , in which B recorded certainty. If both become “B provided an assessment,” the summary can be a conservative weakening of either source. Yet the target distinguishing certainty from uncertainty fails Equation (2). Semantic restraint and useful retention are therefore different requirements.

Conversely, suppose a compact record exactly preserves the fact that B confidently asserted distress. It can satisfy the target criterion while B ’s assertion is false about A . Recoverability of an assertion type supplies evidence about the record history, not a guarantee of the asserted event. The same caution applies to a signed witness statement: the signature can have significance for attribution or confirmation of wording while leaving the underlying observation open to evaluation.

For a family $\mathcal{Q} = \{q_1, \dots, q_m\}$, define the joint target

$$Q(h) = (q_1(h), \dots, q_m(h)).$$

Preserving Q preserves every listed target. A summary could store only the value of Q if that value were known and the purpose were confined to those targets. This construction establishes the possibility of targeted compression. It leaves open later questions absent from Q , the warrant for extracting Q , and the practical interpretability of the resulting codes.

Corollary 5.2 (Closed deterministic chains). *If $\rho_{j+1} = f_j \circ \rho_j$, histories merged by ρ_j remain merged by ρ_{j+1} . A target already unresolved by those merged histories remains unresolved downstream within that closed chain.*

Proof. Equal values of ρ_j have equal images under the same function f_j . Applying Proposition 5.1 gives the target consequence. $\square$

Auxiliary evidence changes the available package. With a further channel η , a reader receives $(\rho(h), \eta(h))$. This can separate histories that ρ merged. A parent link alone usually indicates where additional content might be obtained; recovery improves only if the accessible package actually distinguishes the relevant histories. Source identifiers can nevertheless matter even without full content, because they can reveal dependence among apparent reports.

Improved interpretation also changes practical performance without changing the information in a record. If a rich source contains a clear qualifier that an earlier reader overlooked, a later reader can recover it through more careful analysis. The closed-chain result concerns available distinctions, not the skill of every decoder. Keeping that limitation explicit avoids converting a precise information claim into an unsupported sociology of inevitable institutional deterioration.

5.1 Optimal inference and actual reader error

This subsection makes the limitation about decoding precise. A deterministic summary can improve the performance of a particular reader while reducing the information available to an ideal decision rule. The distinction requires a fixed probabilistic model, target and loss function.

Let $\mathcal{H}$ be finite, with probability mass $\mu(h)$. Let $q(h)$ be the target, $\mathcal{A}$ a finite set of answers and $\ell(q(h), a)$ a declared loss. For a representation ρ , define

$$\mathcal{B}(\rho) = \min_{\delta: \rho(\mathcal{H}) \rightarrow \mathcal{A}} \sum_{h \in \mathcal{H}} \mu(h) \ell(q(h), \delta(\rho(h))).$$

The minimum exists because the decision-rule set is finite. It gives the best achievable expected loss within this specified problem. It is distinct from any actual reader's performance.

Proposition 5.3 (Optimal-risk comparison for a closed summary). *If $\sigma = f \circ \rho$, then $\mathcal{B}(\rho) \leq \mathcal{B}(\sigma)$ for the same prior, target, answer set and loss.*

Proof. For any rule δ_σ based on σ , the rule $\delta_\rho = \delta_\sigma \circ f$ based on ρ gives the same answer at every history. Its expected loss is identical. The minimization over all rules based on ρ includes these composed rules and can therefore achieve at least as low a loss. $\square$

Take $\mathcal{H} = \{0, 1\}$ with equal probability, $q(h) = h$, $\rho(h) = h$ and a constant summary $\sigma(h) = 0$. Under zero-one loss, the best rule based on ρ has risk zero, while the best rule based on σ has risk $1/2$. Yet an actual reader who systematically reverses the rich record has risk one. A reader who always answers zero after the summary has risk $1/2$. Actual error has improved across this pair of readers despite the loss of discriminating information.

This counterexample explains the proper scope of a claim about downstream deterioration. Under fixed assumptions, optimal risk cannot improve through a closed deterministic summary. Actual institutional performance can improve through clearer presentation, better interpretation or correction of a poor rule. A changed loss function, target, prior or source package also changes the comparison. Those possibilities require separate investigation when assessing a summary chain.

The loss function introduces an additional normative question in an investigation. False attribution of certainty and failure to detect a relevant qualification may have different practical consequences. A single error rate can conceal those differences. A study should either state the loss weights and their justification or report the distinct errors separately. The mathematical inequality remains conditional on the chosen loss; it establishes no universal ordering of institutional outcomes.

Proposition 5.3 therefore complements exact recovery. Recovery asks whether a target can be determined for every admitted history. Optimal risk asks how well a decision rule can perform on average under a specified distribution and loss. A representation can fail exact recovery while retaining low expected risk if ambiguous histories receive little probability. Whether that is acceptable for a consequential institutional use requires an independent assessment of who bears the remaining errors.

6 Repeated Records and Evidential Dependence

This section derives a finite example of apparent corroboration. It compares three independent reports with three copies of one report, then permits uncertainty about the generating structure. The numerical probabilities are stipulated for a mathematical witness; they estimate no witness population or investigation.

Let $H \in \{0, 1\}$ be a binary proposition and set $\Pr(H = 1) = 1/2$. A source emits a positive report $X = 1$ with

$$\Pr(X = 1 \mid H = 1) = 0.9, \quad \Pr(X = 1 \mid H = 0) = 0.1.$$

The likelihoods describe the constructed source. A witness's expressed confidence would be a different variable unless independent evidence linked it to those rates.

For one positive source, Bayes' rule gives

$$\Pr(H = 1 \mid X = 1) = \frac{0.9}{0.9 + 0.1} = 0.9. \quad (3)$$

If three observed documents are exact copies of that source, observing all three positives is the same event as observing the original positive. Their number adds no further evidence conditional on the known copying process.

Now suppose three distinct sources have the same stipulated rates and are conditionally independent given H . Their joint positive likelihoods are 0.9^3 and 0.1^3 . Therefore

$$\Pr(H = 1 \mid X_1 = X_2 = X_3 = 1) = \frac{0.9^3}{0.9^3 + 0.1^3} = \frac{729}{730}. \quad (4)$$

The difference between Equations (3) and (4) follows from the source-generating assumptions. Counting documents without identifying those assumptions would conceal the change in evidential model.

Assumption 6.1 (Mixture of source structures). Before the reports are generated, a mechanism selects the common-copy structure with probability $\lambda \in [0, 1]$ and the conditionally independent structure with probability $1 - \lambda$. This selection is independent of H . The source rates and prior remain those stated above.

Let E denote three positive documents. Total probability gives

$$\Pr(E \mid H = 1) = 0.9\lambda + 0.9^3(1 - \lambda) = 0.729 + 0.171\lambda,$$

$$\Pr(E \mid H = 0) = 0.1\lambda + 0.1^3(1 - \lambda) = 0.001 + 0.099\lambda.$$

The posterior is consequently

$$b(\lambda) = \frac{0.729 + 0.171\lambda}{0.730 + 0.270\lambda}. \quad (5)$$

Proposition 6.2 (Dependence uncertainty in the constructed model). *Under Assumption 6.1, b is strictly decreasing on $[0, 1]$. If λ is unspecified within that interval, the sharp posterior range is*

$$\left[0.9, \frac{729}{730}\right].$$

Proof. The denominator in Equation (5) is positive. Differentiation gives

$$b'(\lambda) = \frac{0.171(0.730) - 0.270(0.729)}{(0.730 + 0.270\lambda)^2} = \frac{-0.072}{(0.730 + 0.270\lambda)^2} < 0.$$

The endpoint values are $b(1) = 0.9$ and $b(0) = 729/730$. Continuity supplies every intermediate value, so the range is sharp. $\square$

The construction shows what a provenance fact can contribute. Learning that all three documents copy one source changes the evidential assessment even if the original source’s detailed content remains inaccessible. This is a different benefit from recovering a dropped uncertainty qualifier. Provenance can diagnose dependence without reconstructing lost meaning.

Real dependence can be more complicated. Witnesses may speak to each other, share a vantage point, consult one record, or independently observe different parts of an event. Conditional independence requires more than different names or document identifiers. Conversely, some common context does not make every report a literal copy. A useful model should represent the actual evidential relations at the granularity relevant to the question.

The example also assumes a source mechanism whose selection is independent of the proposition. Selective copying of especially striking allegations or selective retention of corroborating material would require a different likelihood model. The interval above should never be imported as a universal discount for repeated testimony. Its role is to make the dependency obligation explicit and to show that a concrete source fact can materially change an inference.

6.1 Partially shared evidential inputs

This subsection extends the example to reports that combine common material with distinct observations. The purpose is to show why whole-document labels such as independent or copied can be too coarse. All probabilities remain stipulated for the constructed model.

Let X be a shared positive source with the 0.9/0.1 likelihoods used above. Let V_1 and V_2 be two distinct positive inputs, each with likelihood 0.8 under $H = 1$ and 0.2 under $H = 0$. Assume X, V_1, V_2 are conditionally independent given H . Report 1 includes (X, V_1) and report 2 includes (X, V_2) , with no other information or selection effects.

The full positive evidence has likelihoods $0.9(0.8)^2 = 0.576$ and $0.1(0.2)^2 = 0.004$. With equal prior probabilities, the posterior is $0.576/0.580 = 144/145$. Treating the two report bundles as independent would count X twice, producing posterior odds $(9 \cdot 4)^2 = 1296$ and posterior $1296/1297$. Treating both reports as mere copies of X would discard the distinct V inputs and retain only the posterior 0.9.

The two shortcuts make opposite mistakes. One duplicates shared evidence; the other erases independently informative additions. A claim-level provenance map can identify which statements depend on X and which add V_1 or V_2 . The map still needs a warranted likelihood model before a numerical posterior can be justified.

In an actual inquiry, one witness might repeat a common account while independently observing a later departure. Those inputs can bear on different propositions. Combining them under one binary H would require a substantive argument that the evidence concerns the same target and that the likelihood assumptions apply. The constructed calculation should therefore guide the question about source structure without supplying numerical weights for real testimony.

The example also locates a useful preservation target. A short summary can say that two accounts share an initial source while identifying the distinct additions. Such a record may preserve the relevant dependence structure with less information than the full documents. Its adequacy is assessed against the declared question, while later questions may require source access and a richer representation.

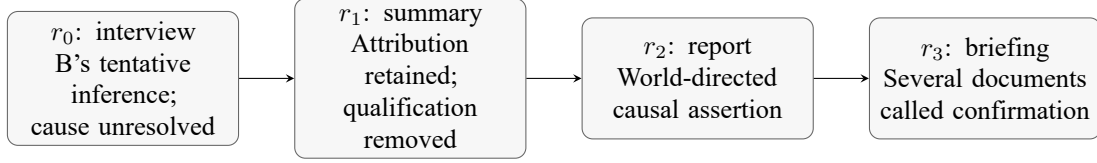


Figure 1: The fictional record lineage. The chain has one original interview; the stronger downstream assertions require warrants beyond their repetition.

Table 2: Summary-chain assessment for the fictional witness account

Record	Attribution and status	Preserved limits	Dependency information
r_0	B’s observation and tentative inference	Cause unresolved; earlier exchange unheard	One interview
r_1	Report attributed to B; certainty altered	Coverage and causal uncertainty omitted	Parent can be recorded separately
r_2	World-directed causal assertion	Original qualifications absent	Derivation concealed in sentence
r_3	Asserted confirmation	Qualifications absent	Three documents treated as corroboration
r_*	B’s tentative account retained	Cause and coverage limits retained	Shared interview and versions explicit

7 A Fictional Investigation Packet

This section constructs a complete summary chain and two repairs. The packet supplies exact source text invented for the example, identifies each transformation and evaluates the resulting records against the formal criteria. It illustrates record fidelity while preserving uncertainty about the underlying event.

Figure 1 displays the actual lineage stipulated for this packet. It locates content strengthening at particular transformations and keeps the single original interview visible. The number of downstream documents can then be distinguished from the number of evidential origins.

At 16:00, witness B provides an account concerning a meeting at 10:00. The source record r_0 states: “A left soon after D spoke. I thought A might be upset. I could not tell whether D’s comment was the reason. I did not hear the earlier part of the exchange.” This fictional wording contains an observation, a tentative mental attribution, unresolved causation and a coverage limit.

The first summary r_1 states: “B reported that A was upset after D’s comment.” The second summary r_2 states: “A was distressed by D’s comment.” A briefing r_3 states: “The interview, investigation summary and review report confirm distress caused by the comment.” Each sentence is concise. Their differences concern what is asserted, whose interpretation it is, and how many sources appear to support it.

At the first step, the phrase “was upset” removes the explicit tentativeness of the source. Depending on the interpretation of reported, the attribution to B may remain while the strength of B’s stated view changes. The temporal word after can preserve sequence without establishing causation, but the sentence invites ambiguity about that relation. A responsible audit should identify both the unambiguous loss of qualification and any interpretive uncertainty about the summary.

At the second step, the external attribution disappears and the causal relation becomes explicit. A scenario in which B held a tentative interpretation while A left for an unrelated reason remains compatible with r_0 . It conflicts with r_2 . The transformation fails the conservative condition on the stipulated domain. At the third step, three documents descended from one interview are presented as confirmation. The source-dependence issue now compounds the content change.

Table 2 gives a target-specific assessment.

A repaired concise summary r_* states: “B observed A leave after D spoke and tentatively inferred

distress. B left the cause unresolved and had missed the earlier exchange. Subsequent summaries derive from this interview.” It retains the selected targets while using fewer details than a full transcript. The repair still relies on the accuracy of r_0 and the interpretation of B’s words. It supplies no proof that A was distressed.

A second repair uses a short public summary plus a controlled source route. The public part identifies B’s tentative assessment and the shared origin of later records. An authorized reviewer can access the exact interview wording and version history when a challenge makes them relevant. The package can preserve more than the public sentence alone, provided access is effective for that reviewer. A broken link or inaccessible archive changes the available information.

Now introduce a later account from A stating that the departure concerned an unrelated appointment. That account supplies a new evidential input whose contribution should be recorded separately from corrections to summary wording. It can change the evidence about the event while leaving the historical fact that B tentatively inferred distress unchanged. A revised institutional assessment should link the new input and distinguish the changed event assessment from correction of the earlier summary.

The packet exposes the division of labor among the criteria. Semantic restraint detects the unwarranted strengthening. Target recovery detects loss of tentativeness and coverage. Provenance identifies shared origin. New testimony changes the evidential basis. A useful investigation preserves these distinctions so that a correction can address the actual defect without pretending to resolve every question at once.

8 Correction, Versioning and Changing Questions

This section examines how records can improve over time. It distinguishes corrections to wording, revisions of interpretation and changes in an investigation’s target. The argument explains how a history of amendments can support both accountability and accurate present use.

A correction to wording can restore what a witness actually said. If an interview note omitted a qualification and the witness identifies the omission, the corrected version should record the change and its basis. The earlier version remains relevant to understanding how a later summary acquired its form. Retaining that history need not imply treating the corrected wording and the superseded wording as equally authoritative for every purpose.

A revision of interpretation is different. B might later say that the initial inference of distress now seems doubtful after learning about A’s appointment. The source history then includes an earlier tentative belief and a later reassessment. Both can be accurately recorded. Replacing the earlier belief with the later one would erase a relevant feature of the investigation’s trajectory, while using the earlier belief as B’s current position would misrepresent the present.

An institutional finding introduces a further role. A panel may consider the accounts and reach a conclusion under a specified standard. That finding can acquire procedural consequences even when historical uncertainty remains. Its record should distinguish the evidence considered, the inferential reasoning and the authority by which the conclusion was adopted. The reality of the finding as an institutional act does not make every proposition it contains true about the event.

Version relations can be represented by a directed graph $G = (V, E)$. Each node is a particular record version. An edge can indicate copying, summarizing, correcting or adding an inference. These edge types should remain distinguishable. A correction edge identifies a relationship between versions; it leaves the reason and scope of the correction to explicit content. A graph with unlabeled arrows may preserve chronology while erasing what changed.

For a specific audience a , let

$$\rho_a(h) = (\text{visible record content, available metadata, accessible source routes})$$

denote the available package. This expression is schematic because an access route has practical conditions: permissions, time, resources and intelligibility. Exact recovery can be assessed only after specifying

ing what the audience can actually obtain. Potential access for an administrator is different from effective access for a person challenging a statement.

Changing the question can also change adequacy. A summary that accurately records the number of interviews may be sufficient for an administrative workload question. It may fail to preserve which interviews contain first-hand observation. If the later inquiry asks about corroboration, the target family has expanded. The earlier summary need not have been defective for its original purpose. The new use requires a new preservation assessment.

Proposition 8.1 (Additional targets and adequacy). *If a representation preserves every target in $\mathcal{Q}_2$ and $\mathcal{Q}_1 \subseteq \mathcal{Q}_2$, it preserves every target in $\mathcal{Q}_1$. Preservation of $\mathcal{Q}_1$ alone leaves preservation of additional targets open.*

Proof. Each target in $\mathcal{Q}_1$ is among those already preserved. For the converse limitation, choose two histories with the same interview count and different source origins. A count-only representation preserves the first target and fails the second by Proposition 5.1. $\square$

The proposition gives a simple discipline for reuse. A record should identify its purpose sufficiently for later readers to assess whether their question requires more. A concise statement of known omissions or scope can help. This is more realistic than expecting an initial record to anticipate every possible future inquiry.

Correction should remain proportionate. Keeping every intermediate copy in a broadly accessible folder may create confusion and privacy risks. A controlled history can identify which version is current, what materially changed and which earlier version supports a provenance question. The governing choice concerns retention and access as well as content. The present analysis supplies the distinctions needed to make that choice explicit, while the appropriate institutional policy remains a separate research task.

9 Institutional Authority and the Conditions of Inquiry

This section considers the philosophical significance of preserving attribution and uncertainty. It separates evidential authority from procedural authority and asks how documentation affects the person's ability to challenge an account. The analysis treats institutional records as consequential social acts while retaining the fallibility of their content.

A summary can change the practical situation of the person it describes. An allegation entered into an official system may affect access, duties, reputation or the direction of an inquiry. Those effects can occur even when the allegation is false. The record therefore has at least two relevant objects of investigation: the event it describes and the institutional consequences of its own production. Confusing them can make social effectiveness appear to verify historical truth.

Procedural authority concerns who may adopt a finding and what consequences follow under an institution's rules. Evidential authority concerns the grounds for believing a proposition. A duly authorized panel can reach a mistaken conclusion. An unauthorized observer can possess accurate information. The distinction does not make procedure irrelevant to truth-seeking; it shows why the quality of an institution's inquiry depends on how its procedures obtain, interpret and test evidence.

The source discussion's concern with another person's experience is especially important here. A witness's statement that A felt humiliated can have a different epistemic basis from A's own account. A later report should preserve whose perspective is being represented. First-person testimony can deserve distinctive attention while remaining interpreted in context. Acknowledging that status does not require treating every retrospective formulation as an infallible description of an earlier mental state.

An institution can also change the conditions under which testimony is produced. A person may narrow an account after anticipating how a committee will read it, omit uncertainty to sound credible, or adopt institutional vocabulary to make an experience legible. These are analytic possibilities requiring empirical investigation. They locate the initial source record within the social interaction whose evidential consequences require assessment.

Preserving uncertainty supports answerability in two ways. It gives a later reader a basis for evaluating how a conclusion exceeded or followed from its inputs. It also gives the person described a more precise object to challenge. Someone can dispute the inference of distress, the alleged cause, the accuracy of the quotation or the authority of the finding. A record that collapses them into one sentence makes such a challenge harder to formulate and assess.

The capacity to challenge depends on more than logical recoverability. A source may be retained but practically inaccessible. A person may receive the relevant document in a language or form they cannot readily use. The deadline may expire before an authorized source request is answered. These conditions matter to the realization of the proposed preservation benefits. A technically complete archive can coexist with weak practical answerability.

At the same time, broader access can create additional burdens. A witness may have disclosed unrelated personal information, and a record may identify third parties whose privacy deserves protection. The proposed framework therefore assesses a package for a specified audience and purpose. It permits controlled access, redaction and limited extracts when the reasons and consequences are explicit. The inferential cost of a restriction should remain visible without implying that every restriction is unjustified.

The normative bridge can now be stated. If an institution owes affected people a fair opportunity to understand and challenge the basis of consequential findings, then preserving relevant source distinctions is one means of fulfilling that obligation. The conditional begins with an independently defended institutional duty. The factorization theorem identifies what a representation can recover; it does not itself establish the duty, determine a disclosure right or override other legitimate constraints.

10 A Proposed Evaluation of Summary Packets

This section specifies a study that could test the practical usefulness of the framework. The design uses constructed source histories to establish ground truth for record targets while leaving claims about actual experience outside the scoring model. It separates content quality, source access and dependence information.

The first factor concerns summary transformation. One condition preserves attribution and qualification; another removes qualification while retaining the same basic event vocabulary. A third, useful for distinguishing the formal criteria, weakens the source conservatively but omits a target needed by the task. The comparison can test whether readers recognize that cautious wording and adequate retention are different achievements.

The second factor concerns the available package. Participants receive the summary alone, the summary with a provenance map, or the summary with provenance and access to the source text. A provenance map can identify shared origins without revealing the source's omitted words. The full-source condition can supply those words. Keeping these conditions separate avoids attributing a benefit from additional content to metadata alone.

The third factor concerns source generation. Several documents can share one stipulated source or derive from distinct stipulated sources. The task should explain the evidential meaning of those structures at the level needed for the question. If a numerical probability task is used, the likelihood assumptions must be supplied explicitly. A participant's ability to calculate the constructed posterior is different from their ability to assess a real witness's reliability.

Table 3 identifies outcomes and their limits.

The primary comparison should be declared in advance. For example, the study could test whether access to the source improves recovery of a dropped qualification beyond the effect of a provenance map alone. A distinct comparison could test whether the map improves recognition of common origin. These comparisons directly follow from the theoretical separation. Combining them into one overall packet-quality score would conceal the mechanisms the design is intended to examine.

Several controls matter. Record length should be tracked because more reading time can account for performance differences. Interface complexity should be kept comparable where feasible. Source access should be recorded, since assignment to a source-access condition differs from actual use. Order

Table 3: Proposed outcomes for a study of testimony-summary packets

Outcome	Scoring basis	Interpretation limit
Attribution accuracy	Scripted author, observer and target roles	Tests record interpretation
Qualification recovery	Explicit source certainty and coverage	Leaves underlying event truth open
Transformation detection	Known changes between source and summary	Depends on the declared semantics
Dependence recognition	Stipulated parent structure	Does not estimate real witness reliability
Calibrated model inference	Supplied prior and likelihood model	Mathematical task differs from institutional judgment
Practical usability	Time, source requests, errors and reported burden	Requires participant and context interpretation

and learning effects should be considered if participants see several packets. A repeated task may teach the importance of qualifications, changing later performance.

Confidence judgments can supplement accuracy when their target is explicit. Participants might estimate confidence that the source expressed uncertainty, confidence that A was distressed, or confidence that an institutional finding was warranted. These are different judgments. A source-text condition can legitimately increase confidence about the first while leaving the second low. The study should reward that pattern where the scripted evidence supports it.

A later field study would require a different evidential design. Real investigations rarely provide certain labels for every relevant event or experience. Evaluation could examine documented correction opportunities, agreement about source wording, the preservation of disputed qualifications and the practical burden of accessing evidence. Claims about improved final decisions would need a defensible comparison and an independent account of decision quality.

The design remains prospective. No participants have been recruited, no response data collected and no empirical effect established. Its role in the paper is to show how the formal distinctions produce testable comparisons with interpretable outcomes. A successful study would support a bounded improvement in record use; wider institutional recommendations would require further evaluation.

11 Objections and Limits of the Preservation Framework

This section tests the framework against objections about language, information, privacy and institutional practice. The responses identify which assumptions can be relaxed and which limits are integral to the contribution. The objective is a usable account whose claims remain proportional to their evidence.

11.1 Semantics and ordinary language

The first objection concerns the definition of $K(r)$. Ordinary testimony can be ambiguous, context dependent and pragmatically qualified. An analyst may assign a single interpretation that understates those difficulties. The objection is correct: the theorem operates after an interpretation convention has been specified.

A practical audit can retain several admissible semantic readings. It can then report whether a transformation fails restraint under every reading, under some readings, or only under a contested one. The statement “A was distressed by the comment” plainly adds causation to the fictional source. A phrase such as “reported distress after the comment” can require more careful examination. The model should locate this interpretive disagreement, not disguise it behind set notation.

The distinction between semantics and pragmatics also limits mechanical checks. A heading labeled confirmed facts can strengthen the apparent force of a cautiously worded sentence beneath it. A footnote can preserve a qualification that readers rarely encounter. A literal text comparison may miss both. The relevant record is the interpreted package in its actual presentation and use.

11.2 Conservative summaries and new knowledge

The second objection is that institutions need to draw conclusions, including conclusions absent from an individual source. The framework accommodates that requirement by identifying the full input package and the inferential operation. A conclusion supported by several independent sources is a new assessment. It should be evaluated against those inputs and their warrants.

Conservative transformation applies when an output is presented as a summary of specified content. It prevents silent strengthening under that description. An institution can make an explicit inference, explain its basis and accept responsibility for it. That separation makes the institution's reasoning available for assessment.

Similarly, correction of a source can require additional information. Restoring an omitted phrase is a fidelity repair. Revising an event assessment after new evidence is an epistemic update. The two operations can occur in the same document, provided the record makes their different reasons intelligible.

11.3 Information loss and interpretive improvement

The third objection notes that summaries can improve understanding. A carefully organized account can make an important distinction easier to see than a long transcript. The factorization result is compatible with that possibility. It concerns the distinctions available in a representation, while actual understanding depends on the reader and task.

An exact target summary can reduce irrelevant detail and improve practical performance. A later reader can also repair an earlier decoding error without acquiring new information. The proposed evaluation should therefore measure both preservation and usability. A record that retains every distinction in an unusable form may perform poorly for the intended inquiry.

11.4 Dependence and the value of agreement

The fourth objection is that agreement among related witnesses can still matter. Shared origins do not make all further statements evidentially identical. One witness can add an independent observation to a common narrative, and a later author can independently check a claim against another source.

The response is to represent the actual input structure at a useful granularity. A whole-document copy label can be too coarse when some claims have new support. The finite mixture example intentionally isolates two extreme structures so that the effect is derivable. Its numerical values belong to that model. Practical source assessment requires claim-specific provenance where dependence differs across claims.

11.5 Privacy, finality and retrospective burden

The fifth objection concerns preservation itself. Retaining a disputed allegation indefinitely can expose a person to repeated harm. Broad access can endanger witnesses or disclose unrelated private information. Reopening every historical question can also consume resources and undermine justified finality.

The framework establishes no universal retention mandate. It identifies what particular packages preserve and what later questions they can support. Normative and legal analysis must determine which targets merit retention, for which audiences and for how long. A restriction can be justified while leaving an evidential cost that should be acknowledged.

Finally, the framework could be misused to discredit testimony simply because it contains uncertainty. A tentative account can be honest, informative and well warranted. Preserving its uncertainty should permit proportionate evaluation. Treating uncertainty as a defect to be eliminated would encourage the very false certainty the paper seeks to expose.

12 Further Research and the Scope of the Results

This section identifies the work needed to extend the framework beyond its present conditional results. It separates mathematical refinements, empirical investigation and institutional design. The closing synthesis returns to the original concern with preserving the conditions of later understanding.

The formal construction supports several extensions. A richer semantic account could represent nested attribution and conflicting testimony without allowing inconsistency to trivialize entailment. A stochastic summary channel could express variability in transcription and interpretation. A claim-level provenance graph could combine copied material with independently checked additions. Each extension should specify its target and preserve the distinction between source fidelity and world accuracy.

An important open problem concerns partial semantic preservation. Exact recovery of every declared qualification can be too demanding when communication crosses languages, professional vocabularies or modes of expression. A bounded adequacy relation might preserve the practical distinction relevant to an inquiry while permitting several formulations. Such a relation would need explicit loss criteria and counterexamples. A general claim that meaning is preserved would remain insufficient.

Another direction concerns adaptive source access. A reviewer may begin with a concise packet and request further sources only when a disputed target becomes relevant. The design problem would ask which retrieval options preserve the possibility of resolving the target under resource and access constraints. It would differ from a demand to expose all source content at the outset. The normative reasons governing access would remain part of the specification.

Empirical research should distinguish several possible failures: inaccurate extraction, loss of qualification, mistaken attribution, false independence and overconfidence about world truth. Their causes and remedies may differ. Training that improves recognition of copied sources might leave causal overstatement unchanged. A longer summary might preserve qualifications while reducing comprehension. The proposed study supplies comparisons capable of detecting such mixed outcomes.

Institutional research should also examine who benefits from a record's clarity and who can challenge it. A well-designed internal packet can aid a panel while remaining inaccessible to the person described. Effective answerability requires an audience-sensitive account of access and intelligibility. The current formal results can identify information conditions, while the distribution of rights and burdens requires independent justification.

The established consequences within the stated models are limited and useful. Conservative transformations compose. Exact target recovery requires constancy across histories merged by the available package. Copied reports and independent reports have different likelihood structures. Uncertainty about the generating structure can produce a range of warranted model conclusions. None of these consequences guarantees that the source account is true or that a resulting finding is just.

The paper's proposed contribution is to make those limits operational in the design of testimony summaries. A record should preserve enough of its target, attribution, qualifications and actual sources for its intended use, and it should identify when a later author adds an inference or changes the question. Such preservation can support future understanding without pretending to retain every aspect of experience. Its practical value will depend on the quality of interpretation, the accessibility of the record and the institution's willingness to respond to justified correction.

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