InterPARES 2 Project

International Research on Permanent Authentic Records in Electronic Systems

Focus 2 General Study Research Proposal

Testing of the ATF's Method of Assessment with the Benchmark Requirements for a Presumption of Authenticity

Rationale (Research Questions)

How can the method for assessment of authenticity based on the Benchmark Requirements be more precisely specified and tested so that a preserver could be confident that he could apply the method and Requirements and be confident in the result?

This research question arises as a result of the Authenticity Task Force' research addressing the conceptual requirements for presuming the authenticity of electronic records, and is a preservation question as well as it bears on how the preserver can assess the authenticity of transferred records. Quoting the Authenticity Task Force:

> A presumption of authenticity is an inference that is drawn from known facts about the manner in which a record has been created, handled, and maintained. The evidence that supports the presumption that the creator created and maintained its electronic records authentic are enumerated in the Benchmark Requirements Supporting the Presumption of Authenticity of Electronic Records (Requirements Set A). A presumption of authenticity will be based upon the number of requirements that have been met and the degree to which each has been met. The requirements are, therefore, cumulative: the higher the number of satisfied requirements, and the greater the degree to which an individual requirement has been satisfied, the stronger the presumption of authenticity. This is why these are termed 'benchmark' requirements.[1]

The ATF and PTF have not actually tried to assess the authenticity of a creator's electronic records using the Benchmark Requirements. Experiments should be conducted to determine whether the Benchmark requirements and the method of assessment actually achieve what is intended.

While the method of assessment is expressed in simple terms, there are substantial pitfalls inherent in subjective probability assessment due to psychological biases and common

[1] Ibid, pages 34-35.

misunderstandings of probabilistic reasoning.[2] Furthermore, the conditional dependencies between requirements and between the evidence needed to conclude that a requirement is met can be quite complex.

- Suppose a preserver has just seen that the name of the addressee was not included in the metadata associated with a record, then his subjective estimate of the likelihood that the record system will contain other records in which the name of the addressee is not associated with a record will temporarily rise. The event is salient, and therefore more available. But the judgment may be in error.

- Where does uncertainty lie? When assessing the authenticity of electronic records, does the uncertainty concerning the authenticity of the records lie in the preserver, or is it a property of the records system? Does uncertainty come from within the preserver, or is it an intrinsic property of events in the environment? If you opted for the second option, that is, that uncertainty is a property of events in the environment, then you are subject to the fallacy of denying uncertainty. You believe you can control it. For example, you may be a clever preservation manager who believes she can avoid uncertainty and actually reduce risk by skillful action. But the answer is that uncertainty is attributable to you. Acknowledgement of this fallacy is vital to any attempts to quantify subjective probabilities about uncertain events.

- Suppose that the preserver observes the metadata attributes associated with a record. The metadata should contain the name of the author and the name of the addressee of a record, but not all metadata for records includes the name of the author and the name of the addressee. Which is more probable: The metadata contains both the name of the author and the name of the addressee, or the metadata contains only the name of the addressee? If you selected the first option your incorrect. From elementary probability theory, the probability of a conjunction P(A & B) cannot exceed the probability of either of its constituents, P(A) or P(B). This is the conjunction rule. However, it is often the case that the conjunction is more representative of its class than either of its constituents, or more available in some way, and therefore judgments of its probability are subject to one of the representativeness or availability.

- Overconfidence occurs when accumulating evidence, for example, from case-study material about authentic records, from which certain predictions are then made. There is a point in the information-gathering process when predictive accuracy reaches a ceiling. Nevertheless, confidence in one's conclusions continues to rise as more information is received. Towards the end of the information-gathering process, most judges are overconfident about their judgments.

- Two preservers applying the Benchmark requirements to a record creator's procedures, and having the same evidence can have a different degree of belief as to

[2] D. Kahneman, P. Slovic and A. Tversky (eds). *Judgement under Uncertainty: Heuristics and Biases*. Cambridge University Press, 1982. G. Wright and P. Ayton (eds). *Subjective Probability*. John Wiley & Sons Ltd., 1994.

> the presumption of authenticity that should be accorded a record creator's electronic records. One reason this can occur is that they have different preferences with regard to risk. Risk takers will tend to overestimate and risk adverse people will tend to underestimate.

The Bayesian approach to reasoning under uncertainty is one approach to reasoning with degrees of belief while dealing with the complexity of conditional dependencies. Combined with Bayesian Belief Networks, it can also expose and overcome some of the common psychological biases and fallacies in reasoning due to misunderstanding of probability.[3] Hence, the original research question might be reformulated as:

Can the method for assessment of authenticity based on the Benchmark Requirements be more precisely specified and tested using Bayesian Probability and Bayesian Belief Networks so that a preserver could be confident that he could apply the method and Requirements and be confident in the result?

The Authenticity Task Force notes that:

> …there may be an insufficient basis for a presumption of authenticity, or the presumption may be extremely weak. In such cases, further analysis may be necessary to verify the authenticity of the records. A verification of authenticity is the act or process of establishing a correspondence between known facts about the record and the various contexts in which it has been created and maintained, and the proposed fact of the record's authenticity. In the verification process, the known facts about the record and its contexts provide the grounds for supporting or refuting the contention that the record is authentic. Unlike the presumption of authenticity, which is established on the basis of the benchmark requirements, this verification involves a detailed examination of the records themselves and reliable information available from other sources about the records and the various contexts in which they have been created and maintained.

This suggests the research question:

How does an assessment of the authenticity based on the Benchmark Requirements compare with the results of some method of verification of authenticity?

Research Methodologies

Bayesian probability is a formal notation and theory that allows one to reason about beliefs under conditions of uncertainty. If we have observed a specific event, then there is no uncertainty. However, suppose H is the statement

> "All of the 40,000,000 email records of the Executive Office of the President that

[3] There are other methods of modeling decision making under uncertainty, e.g., Dempster-Shaefer, Truth Maintenance, Fuzzy Logic, Logical and Probability that would lead to similar research questions.

were transferred to the National Archives are authentic."

Since no one will examine each of these records at the time of transfer, nobody can state with any certainty whether or not the statement H is true. Different people may have different beliefs in the statement depending on their specific knowledge of factors that might affect its likelihood.

A person's subjective belief in a statement H will depend on some body of knowledge K. This can be represented as the conditional probability P(H|K) that a hypothesis H is true (e.g., that a requirement is met) given available evidence or knowledge K. The expression P(H|K) is a measure of a person's belief in the truth of H warranted by the K.[4]

The definition of the conditional probability of A given that B is true or known is the joint probability of A and B divided by the probability of B.

$$P(A|B) = P(A, B)/P(B)$$

It follows as a theorem (known as Bayes rule) that

$$P(A|B) = P(B|A)\, P(A) / P(B)$$

Bayes rule can be thought of as a means of updating ones belief about a hypothesis A in light of new evidence B. Specifically, ones posterior belief P(A|B) is calculated by multiplying their prior belief P(A) by the likelihood P(B|A) that B will occur if A is true.

In those cases where P(A|B) = P(B), A and B are said to be *independent*. If P(A|B, C) = P(A|C), A and B are said to be *conditionally independent given C*.

A Bayesian Belief Network (BBN) is a graphical notation with an associated set of probability tables. The graph consists of nodes and arcs representing conditional dependencies P(A1|A2, …An). The key feature of BBNs is that they enable one to model conditional dependencies of variables and to reason using degrees of belief. BBN's provide an intuitive visual representation that can aid in clarifying implicit assumptions made by an expert. With BBNs, it is possible to articulate expert beliefs about the dependencies between different variables. BBNs can also expose and overcome some of the common psychological biases and fallacies in reasoning due to misunderstanding of probability. However, the most important use of BBNs is in revising probabilities in light of actual observations of events. Furthermore, there are software tools that implement the algorithms for propagating the results of new evidence through the BBN, as well as providing a graphical user interface to draw the graphs and fill in the probability tables.

To develop a BBN, one must elicit expert knowledge of the concepts and causal connections in the Benchmark Requirements that will comprise the topology of the network, and the

[4] C. Howson and P. Urbach. *Scientific Reasoning: The Bayesian Approach*. Second edition. Open Court, Chicago, 1993.

probabilities comprising each node's probability table.[5] Then an experiment would be conducted in which a human subject acting as a preserver/assessor would use case study data from an actual records system to estimate the degree of belief in the terminal nodes of the BBN. As the estimates are entered the degrees of belief are propagated the BBN. Difficulties encountered during the assessment will be recorded and analyzed to determine whether the method achieves its intended objective.

The experiment might be repeated with case study data for another electronic record system. Other experiments might consider how the results of an assessment using the Benchmark Requirements and a BBN compared to the results of an attempt to verify the authenticity of the electronic records using some other method.

Description of the Case Study Subject

The case study data will be collected from a specific NASA Spacecraft Mission Operation and a NASA Space Science Data (and Records) archive. This data could be collected at the same time the data was collected for "Validation of the InterPARES Preservation Model Using Records and Data from a NASA Spacecraft Mission Operation."[6] The case study subject here is not just the creator's electronic records system but a human subject acting as a preserver using the BBN to assist in assessing whether the records can be presumed authentic.

Research Team

Lead investigator: Bill Underwood
Co-investigator: PC Hariharan
Research Assistant: Georgia Tech graduate students

Timeline:

1. Develop BBN for generic problem of assessment of authenticity based on the Benchmark Requirements.
2. Progress Report, InterPARES Workshop, Sept. 2002
3. Continue development of BBN and Design data collection
4. Human subjects approval
5. Make arrangements with NASA Spacecraft Mission Operation to collect data
6. Collect data
7. Experiment in which a human subject reviews case study data and enters degrees of belief into the BBN. Analysis of results.
8. Interim Report, InterPARES Workshop, Feb. 2003
9. Additional experiments
10. Final Report, InterPARES Workshop September 2004

[5] Meyer, M. and Booker, J. "Eliciting and Analyzing Expert Judgement. A Practical Guide." Knowledge *Based Systems* Volume 5. Academic Press, 1991.
[6] Another research topic and case study proposed by Bill Underwood.